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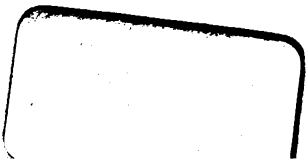
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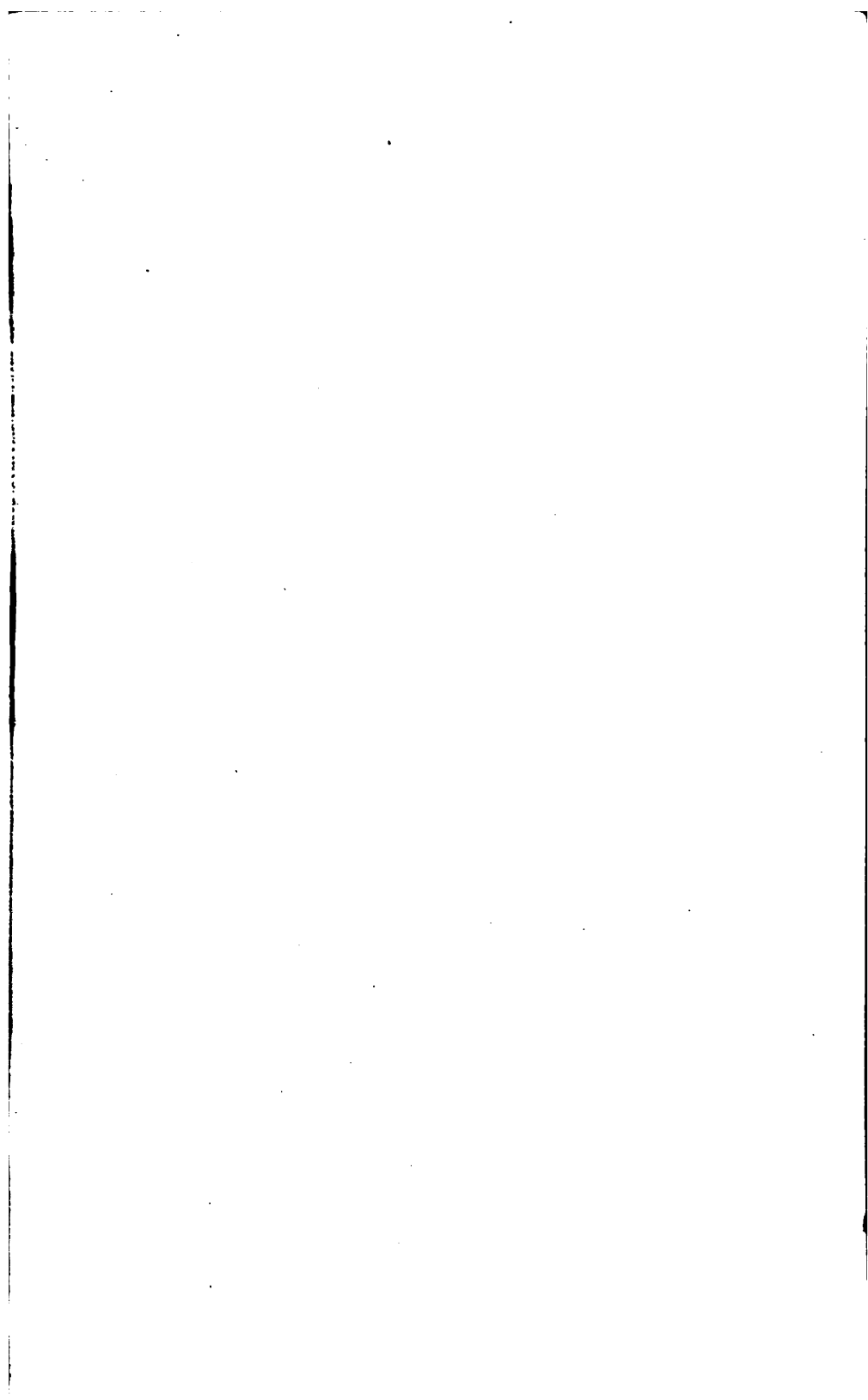


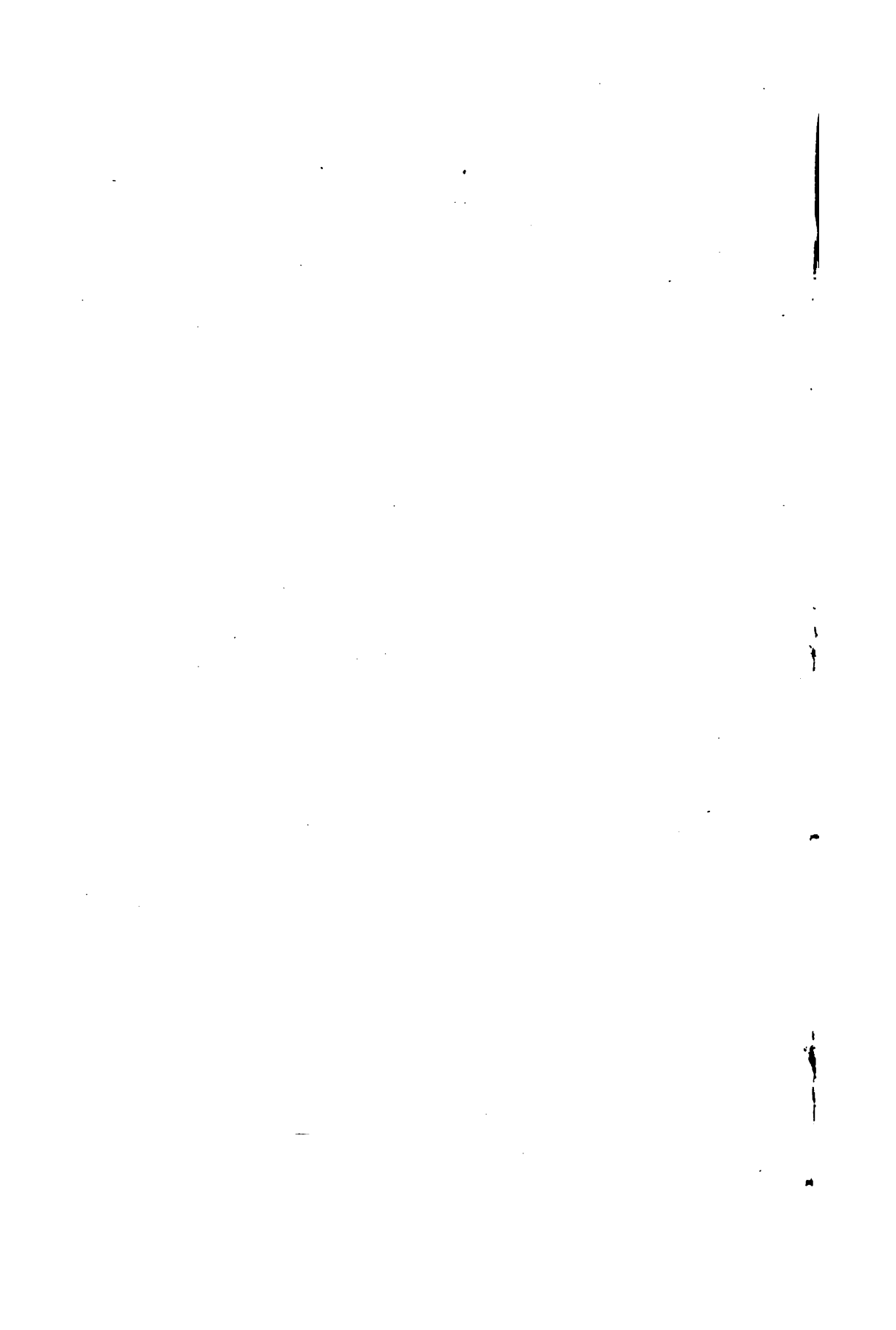
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ANTISEPTIC SURGERY.

THE PRINCIPLES, MODES OF APPLICATION,
AND RESULTS OF

THE LISTER DRESSING.

BY

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THE SPECIAL SANCTION OF THE AUTHOR,

AND EDITED BY

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1881

TRANSLATOR'S PREFACE.

ALTHOUGH for more than a decade it has been hardly possible to glance through a medical journal without seeing something concerning the Lister method, there are comparatively few medical men in this country who have a sufficiently good knowledge of this modern system of treating wounds to enable them to apply it with essential accuracy. The result is that it is either not used at all by most surgeons, or else is incorrectly employed with disappointing results, which are not fairly attributable to the method. This condition of affairs is probably largely due to the fact that there has been no low-priced treatise on the subject in the English language, from which one could acquire the necessary information with regard to the principles, practice, and results of Antiseptic Surgery. With the desire of supplying my fellow practitioners in America with such a work, and thus enabling them to experience the benefits of a method which will do more than any other to lead their surgical patients to recovery without delay, danger, or discomfort, I have translated this work of an eminent French surgeon. Its careful perusal will, I believe, make it plain, not only that the Listerian theory is rational and its practice wonderfully satisfactory, but also that its application is neither difficult, nor seriously expensive.

The book is so nearly exhaustive that there has seemed to me to be need of very little editorial work. A few omissions of an unimportant character have been made, among them that of the bibliographical index, which is confessedly far from complete, and is quite unnecessary to those who have access to the published volume of the Index Catalogue of the library of the Surgeon-General's office, U. S. Army. In the chapter on apparatus, I have omitted the descriptions and pictures of several foreign spray-producers, and have introduced cuts of others which are made in this country, and can, therefore, be obtained more easily and cheaply than those of exotic origin. For the convenience of any who are not familiar with the metric system, a table of equivalents has been inserted near the end of the book.

In a recent letter the author enclosed to me a report of four cases of Porro's operation, and it is so important and interesting that I have included it in the nineteenth chapter.

My own additions to the work will be found in the foot-notes.

F. H. G.

PORTLAND, MAINE,

4th of July, 1881.

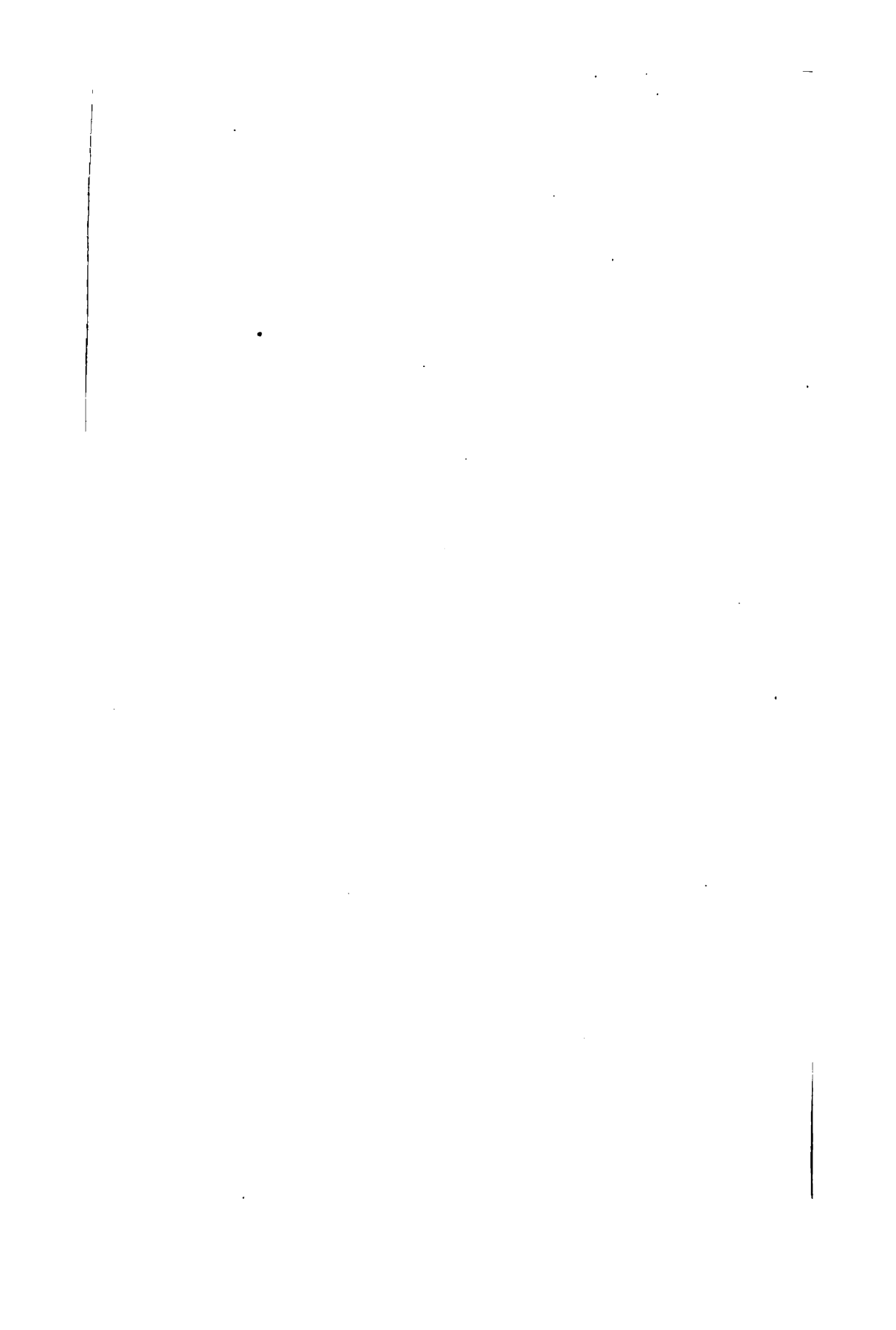
TO
JOSEPH LISTER,

PROFESSOR OF CLINICAL SURGERY IN KING'S COLLEGE HOSPITAL.

I dedicate the Second Edition of this Work to you, in the hope that it may have the same good fortune as the First.

The purpose of the First was particularly to make known the principles and the method. It succeeded beyond my hopes. To-day Antiseptic Surgery is known in France.

This new edition, much more comprehensive, and written with a much larger personal experience, is designed to teach more completely the practice, and how the resources of the method may be best employed. I trust that it will enable all its readers to appreciate the great progress which surgery owes to you.



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ANTISEPTIC SURGERY.

INTRODUCTION.

THE first edition of this book was published not long ago, and now the progress of the antiseptic method is so well known that there is no need of long preliminaries to tell how profoundly it has modified, even transformed, the surgical practice of our time.

The reception with which it has met has undoubtedly varied: even in England it has difficulty in acquiring the position which is its due; in Denmark it reigns supreme; in Germany it has its enthusiasts, since it has undergone changes; in Austria, Switzerland, Holland, Russia, Italy, and America, we meet eminent representatives of Listerian surgery; and, indeed, we believe there is hardly a country where there are not some ardent disciples who proclaim its merits.

In France it has gained a firm foothold, and, although we have had some difficulty in acclimating it in the hospitals of Paris, the situation is such to-day that there is small possibility of its being deposed.

In 1875, when, in my hospital service, I myself provided the materials for the dressing and the necessary apparatus, and undertook to make the first rigorously precise application, in accordance with what I had learned in Scotland, it met with a discouraging reception from many of my colleagues.

But I had followed the first steps of the method since 1867; had seen it applied in Glasgow in 1868; had described it to the French surgeons in January, 1869; had kept it before them in every succeeding year by showing its progress and by introducing into my practice, with great success, the employment of powerful antiseptics. Above all, in 1875, I made at Edinburgh, *de visu*, an exhaustive study of it. So nothing could discourage me or deter me from faithfully testing it.

Soon some of my colleagues, struck by the remarkable cases which I described to them, and surprised by the growing reputation of the method abroad, asked me to teach them the practice of it; and Professors Guyon and Verneuil were the first to be convinced by their own experience of its immense value.

It was with difficulty that, even after a year of effort, of personal trouble, we prevailed upon the administration of the hospitals to furnish the materials for the dressing. To-day they can be had for the asking.

This great step having been taken, there was a chance for the propagation of the Lister method; and I was able to introduce it into the services of my colleagues and friends, and those of which I had charge, where it reigns supreme to-day.

In fact, for four years I have had a large personal experi-

ence with the method, and that, too, in varied services, in widely different hospitals, in some of which I found the most deplorable sanitary condition.

Now, what was this experience? One could tell it in a word: in the Paris hospitals, and in the worst of them, we are obliged to make the most dreaded operations; we perform them with the same sense of security which we should feel in the country where the air is the most pure. We have thus all the outside advantages of the country, and all the facilities which can be furnished only in a hospital.

Nélaton, who was esteemed one of the most fortunate of operators, was accustomed to say that the man who should discover the means of suppressing purulent infection deserved a statue of gold. If this view of Nélaton's was generally entertained, the statue would be raised to Professor Lister; for purulent infection has disappeared from the list of wound complications in the services where his method is followed.

Erysipelas, if not altogether unknown, is infinitely rare. For four years, I have not had a single case after my operations; and yet I can truly say that, during that time, I have made all the operations which are most liable to be followed by this disease and purulent infection.

But this is not all: security against accidents of this nature is, indeed, the chief advantage of the method, but the others are of great value.

The wonderful regularity of repair and the rapidity of healing are two phenomena of the highest importance. Ask a patient who has suffered amputation of the leg whether he prefers to recover in twenty days rather than in two months; ask a woman whose breast has been removed if she would

like better to be cured after one or two weeks, or remain from six weeks to three months with a gaping wound,—and you will have the response which some surgeons are obstinately bent upon not giving.

These facts are not exceptional; they are the regular and constant results of this method of procedure, of which we may say further that the subsequent suffering and the traumatic fever are reduced to the minimum.

The wounds unite immediately in the greater part of their extent, and the remainder does not suppurate.

All the dressings are remarkably neat, are required less and less frequently as a case progresses, and we see disappearing from surgery the epithems, the uncleanness of which can only be compared with that of the pus-covered wounds which they were designed to protect.

The results of this new surgery are so remarkable that they have attracted the attention of the most incredulous. These, as is well understood, will not allow themselves to apply the Lister dressing, but each borrows something from it,—perfect apposition, drainage, but, above all, the use of powerful antiseptics. Everything is laid under contribution; and we see to-day, in all the services in Paris, washing of hands, of instruments, and of patients in carbolized water,—a proceeding formerly unknown.

This kind of thing is not the dressing of Lister; and yet, such is the value of the principal directions so clearly laid down by him, that the results of the surgery of all these imitators are already vastly improved.

As always happens in such cases, it has been contended that Professor Lister did not invent his own dressing; he has been accused of having pretended to discover antiseptics;

and there are even those who deny the immense progress which has come from ascertaining the effects of necessary doses of these antiseptics.

Have we not seen a comparison instituted between the dressing of Lister and that of Azam, of Bordeaux? Is it possible to compare the dressing of Azam, which is substantially only the partial apposition in the stumps after amputation, together with drainage (an affair already known), with a method like that under consideration, which at once inflamed the surgical world? It is well to remember, too, that all publication upon the Azam dressing was subsequent to the announcement of the Lister method, and, better still, that Azam has never laid claim to it at all. With the greatest frankness, in publishing the very remarkable results of his practice, he made known the names of the surgeons who brought to Bordeaux the elements of the amputation dressing: Labat, the deep drain; Dudon, the double suture; Denucé, the perfecting of the superficial suture; and, moreover, each of these elements existed before this dressing.

Doubtless the cause of these quarrels is that the surgical world still considers the dressing of Lister as a procedure, instead of comprehending the fact that it is a method. Any one who has attentively studied or experimented could not make a mistake upon this point. Whoever has followed a service where the antiseptic method is rigorously carried out must have been struck by the fundamental difference in the mode of repair of wounds. It is no longer a question of the more or less perfect healing after a particular operation; but all surgery is affected.

When one has seen wounds heal without suppuration; abscesses, as soon as evacuated, dry up and close rapidly; the

great joints, when opened, allow themselves to be roughly handled without resenting it; clots of blood, instead of interfering with repair, contribute to its perfection, — he comprehends that a new element has entered into surgery. It is not a question of comparing one dressing with others, of making a distinction between various topics. It is necessary to find out by experience whether the advocates of the method have stated facts, or have allowed themselves to be lured away by the promise of novelty.

When we hear it said that this method is a matter of interest only in the great cities, in centres of infection, we regret that it is not better understood. Doubtless it is in the hospital, and the very worst, that it attains the highest degree of interest; for it succeeds, in a way, in making the place healthy. But much more than this: it has so transformed surgery that its employment is called for everywhere. Perchance, in exceptionally favorable conditions, one may omit some parts of the dressing which are indispensable in bad surroundings; but the *ensemble* of the method must remain, and is demanded in the country as well as in town. Certain operations are justifiable only under its protection.

Whatever has been the progress of modern surgery, the antiseptic method came at a time when the surgeon, often disarmed by surgical complications, saw his horizon limited by cruel uncertainties. It was impossible to predict the results of operation, and security was so imperilled that certain conditions appalled the boldest, and certain operations were practically prohibited to the surgeons of cities, who, even though consummately skilful, found themselves unable to produce results equal to those of their far from expert

brethren in the country, where the atmosphere is untainted. The antiseptic method came, and gave an impetus to surgery, for it provided skill with means of success.

This new power of surgery, it seems to me, can be acquired only by faithful disciples, as I shall explain further on. Approximations to antiseptic surgery, and attempts at imitating it, have everywhere ended in cruel disappointment.

Therefore, I have refrained from explaining in this work the modifications of the method which have been suggested, although I have studied them and know that some of them are of interest. Contrary to what has been said, I believe this surgery to be within the reach of all the world; I believe that every one may be so convinced that he will not deviate from the rules which have been laid down. But one can easily understand that, until it is acknowledged as a matter of surgical duty, only a small number will rigorously follow the necessary practice and attain satisfactory results.

For my part, I write the new edition of this work to-day with a very different personal experience from that of four years ago. Whatever I state, I have tried and observed. I have educated myself upon all these points, and, confident of success, I have fearlessly performed operations which formerly one would scarcely have ventured on.

I assert more emphatically than ever that we can do no better than to remain faithful to the words of the master; and that I may deserve to be considered elsewhere, as I am already in the Surgical Society, his apostle, I promise those who shall obey them the following things: —

The disappearance of wound accidents even in the worst circumstances.

A regularity in repair hitherto unknown.

Surgery without suppuration.

Union by first intention habitually and without danger.

Such rapidity in healing as to surpass all anticipation.

The possibility and safety of operations hitherto considered dangerous and even unjustifiable.

This is no vain promise, for these results are obtained daily, and we may be allowed to say with satisfaction that our efforts are crowned with success. A few years ago the hospitals of Paris were reckoned among the worst, even by the verdict of some of their own surgeons. To-day their surgery is as fortunate as that anywhere in the world. Even the Cæsarean operation is successful.

CHAPTER I.

PROGRESS OF SURGERY.—PRACTICES DESIGNED TO PROTECT WOUNDS FROM THE INJURIOUS ACTION OF THE AIR ; OCCLUSION AND ANTISEPSIS IN ANCIENT AND MODERN TIMES.—THE METHOD OF LISTER.

HARDLY any advance has been made in natural science without its having been remarked that discoveries of the same kind preceded the announcement of the modern achievements. This is explained by the fact that in the sciences which depend upon observation, the conditions of experimentation are so complex, so disturbed by circumstances of every kind, that one cannot know at once all the elements of progress. He must advance when he catches sight of the truth, retrace his steps when certain circumstances conceal it from him, then advance again and take a longer and surer step, because all previous experience is pointing out the way to him.

The antiseptic method followed the usual course: it did not come complete from the brain of one man; it would be incorrect to say that it burst suddenly upon surgery like a revelation. The eminent *savant* who has formulated with so much care the minutest directions concerning it does not deny this, nor does any one of his devoted followers.

If we go back to the earliest history of surgery, we find the idea of the harmful effect of the admission of air to solutions of continuity in the human body. In studying the history of surgery, we are continually catching sight of the constant struggle of art with this action,—an empirical

struggle, now abandoned, now renewed with ever increasing success.

Two principal processes have constituted the elements of this struggle,—the *occlusion* of wounds, and *antisepsis*, which we venture to believe was unconscious.

Occlusion is, theoretically, the simplest method of protecting wounds from the action of the air; practically, it is the most complicated. We find the beginning of its history among savages who cover their wounds with sand or mud, and think that their recovery is facilitated by this process.

Two dates, celebrated in the history of occlusion, ought to be especially marked by two names, Magatus and Larrey. Magatus in 1616 not only briefly formulated the directions for occlusion, but wrote an account, marvellous for the age, of the theories of traumatic fever and of septicæmia.

Larrey, with his great military experience, afterwards introduced a valuable method which contrasted with the recognized practice, and shocked the ideas of his contemporaries, but saved many lives. In employing infrequent dressings, he acted empirically, guided by his wonderful clinical instinct. In spite of his natural desire to inspect the wounds, in spite of the dreadful odor emitted by the pus-saturated dressings, he persisted in his practice and obtained remarkable results. In analyzing these results, we find points which are difficult to explain; yet we have a beginning of the interpretation in the science of the infinitely little.

In our modern surgery we find a multitude of occlusion processes. Each of these has been thought to deserve the name of a new method, according as it was more or less complicated, more or less ingenious. In all of these methods there was a common principle, which explains their success: they prevented the circulation and stagnation of air in and

about the wounds, perhaps simply by isolation, perhaps by exhaustion of the air and the altered fluids.

Serious difficulties of application prevented the continuance of these methods, excepting the wadded dressing of Alphonse Guérin, which has rendered services so remarkable, although this eminent surgeon made it known only a few years ago (1871). This does not exclude the air, as the occlusion dressings pretended to do, but filters it, and consequently renders it harmless to the wounded organism. It fulfils yet other conditions, which are of less importance but advantageous to wounds, and constitutes one of the most powerful methods in surgery. We hasten to add that it is no longer an empirical dressing, but is based upon a serious scientific theory of the accidents of wounds, and is now always combined with antiseptic precautions.

Ancient empiricism combated the harmful action of the air by proceedings much more powerful than the occlusion of wounds. There seems to have been a constant effort to change the injured surfaces, so as to avoid the immediate results of the fermentation and putrefaction of dead parts and organic fluids. The instruments by which the modification was produced were various: the actual cautery, boiling liquids, above all, antiseptic substances have played the chief part in the treatment of wounds.

Modern surgery has erred in not holding in greater esteem the prescriptions of the ancients, and in not admitting that so remarkable observers could not have acted without discernment, and without depending upon the mighty facts of experience.

What do we see, in glancing through the surgical pharmacopœia, if not the constant employment of powerful antiseptic substances? Undoubtedly, man does not correctly interpret his own actions; undoubtedly, superstitious prac-

tices induce surgeons to put together substances which are more or less extraordinary, such as serpents, earthworms, and human fat. But, although in his opinion the effect of these substances is largely due to their supernatural power, he takes good care not to use them alone; he always unites them with antiseptics.

These are manufactured products, such as turpentine, wine, brandy, alum, common salt, etc., and many vegetable substances, among which we find aloes, the leaves and shell of the walnut, figs, and many other substances quite as valuable.

Cataplasms even are of infinite variety, and contain antiseptic, aromatic, and other substances. It is only in our time that a panacea has been found in linseed pulp, a fetid topic and natural receptacle of all injurious organisms.

Surgeons do not even neglect the atmosphere, for they advise the employment of aromatic substances, and disinfectants suitable for the fumigation of the sick-chamber.

The most ridiculous and mysterious of their formulas, after all, depend only for their activity on antiseptics, often combined with oily substances which serve as vehicles and to isolate the wounds.

The famous oil of puppies, the secret of which cost Ambroise Paré two years of entreaty, was only a mixture of oil, brandy, and turpentine, in which living puppies and earthworms played the necessary *rôle* of mystery.

The commander's balsam, an alcoholic compound of benzoin, is a type of the antiseptic substances, and its employment has recently been recommended anew.

At a more modern date, and in the most classic works, we also find prescriptions as neat as this of Dionis: "Oily and putrid remedies are of no use in wounds of the head; the balsams and spirits are there of the most advantage, for which one ought to keep white balm and spirit of wine."

If we go from medical works to the histories of chivalry, in which there is no lack of recipes for infallible balms, we again find the employment of antiseptics.

Since the confidence inspired by these substances has continued for ages, it is probable that they have some real action, that their reputation is partly deserved, and it is surprising that surgery should all at once have the vanity to say, "Our fathers were entirely mistaken ;" and henceforth surgery is done with lint, cerate, linseed-meal poultices, and hot and cold water.

Is it necessary to attribute this abrupt change largely to the influence of physiologism, to the doctrine of inflammation, to the work of men whom Velpeau called *antiphlogistiques*, even while he was constantly under their influence?

However it may be, the reaction has come about, and is to be explained first and foremost by an empirical return to antiseptics. A great number of substances of recent production have been extolled, and everybody has been able with reason to praise the favorable influence of a new dressing. Carbolic acid, an entirely modern production, has been recommended by many. We have seen several surgeons employ carbolic-acid dressings, freely using weak solutions of it, and also, what is still more important, sprinkling carbolized water about for the purpose of counteracting the poison of wounds. By these means the wounds heal more rapidly, and the healthfulness of the wards is improved.

But alcohol has attracted the most attention. Ardently advocated by Bataillé and Le Cœur, this dressing had the good fortune to be adopted by Nélaton. Bataillé saw in it the final suppression of purulent infection. Le Cœur, with his dressing, actually returned to the ancient practice, recommending with the alcohol much neglected articles.

This dressing had an advantage over others in being based

upon a theory which was revived by Neudorfer some years afterwards for carbolic acid. Alcohol coagulates albuminoid substances, and makes them imputrescible; it contracts the minute blood-vessels, and renders them incapable of absorption.

Whatever there may be defensible in this explanation, there has been rapid progress in this modern period. All antiseptics, from pure alcohol to dilute caustics, have been employed with varying success, but always with success.

We have seen, then, substances which were formerly thought to be irritant come into ordinary surgical use, hastening and insuring the healing of wounds instead of retarding it.

Doubtless the action of each dressing was capable of an explanation, but sufficient evidence was not adduced to establish it. It was thought that some modified the wound, that others acted upon the secretions, that others afforded protection from the action of the air. It was easy to see that great progress had been made, for surgery was already much improved; but it was difficult to give the reason.

Furthermore, success, though actual, was far from being constant. Although accidents were less frequent and the progress of repair was more regular, still with the failures astonishing discrepancies were observed, which the theories previously advanced did not explain.

Antiseptic surgery, with its constant achievements and its scientific interpretations, begins a new period, marks an important triumph. The regularity of the work of repair, almost without regard to tissues and media, bringing all points of the economy under a common law, is what chiefly attracts the attention of the observer.

The method which Professor Lister has taught since 1866 is evidently connected with the great progress which we record.

This surgeon protects the organism against the hurtful action of the air, at least against those parts of it which are poisonous.

He gives the theory of the action of antiseptics.

He directs and assures the regular course of repair.

He imparts to the organic elements their greatest possible reparative power, by removing everything which he had ascertained to be obstructive to their functions of renewal.

Physiological study, we may say, of the healing wound agrees with the theoretical ideas which he has advanced as necessary conditions. In my opinion, this will be the true criterion of the value of the method, and of the importance of the discoveries to which it will give birth.

The method of Lister is an immediate result of the discoveries of Pasteur. This eminent *savant* explained the cause of the injuriousness of the air. He showed that fermentation is impossible in pure air. But at the same time he demonstrated that everywhere air is impure; that it is surcharged with germs in densely populated localities; that the number of germs is less in country places; and that when we come to the summits of high mountains the scarcity of germs is remarkable, but still there are germs.

Now, according to Lister, as we shall see later, it is not the air itself which is hurtful to wounds, but the germs in the air are the source of their putrefaction and infection, and the cause of accidents.

It is still very difficult to explain the exact mechanism of these accidents. But the researches of Pasteur and his pupils, of Davaine, of Lister, of Bert, of Tyndall, have awakened the study of the evolution of germs in infectious maladies, septicæmia, pyæmia, and even puerperal fever. The pursuit of the micro-organisms, to use Sedillot's happy expression, is made every day, and every day we study

more accurately the conditions of their existence and resistance.

We are beginning to understand that, in the microcosm of the vibrios, all the beings are not equally baleful; how it is that the appearance of certain of them coincides with the disappearance of certain others; how the presence of fresh air, frequently renewed upon a denuded surface, is less favorable to their development than a dressing which imperfectly covers a wound.

We have seen that certain substances, employed as topics and called antiseptics, arrest the evolution and the multiplication of these germs.

We already explain the apparent inconsistencies of the theory and the practice. We know how dressings as different as the wadded, the antiseptic, and even the open dressing act in the same direction; it is by the total or partial destruction or sterilization of micro-organisms. And although the germ theory leaves so many points to be studied, so many obscurities to be lighted up, it certainly draws a decided confirmation from the practices and theories of modern surgery.

Science advances; till now we have destroyed the germ without seeing it, almost without knowing it. Thanks to modern observers, we have caught the vibrio in the process of evolution; we study it, and every day new proofs are added to the experiences upon which are based the theory of the harmfulness of the air and the practice of antiseptic surgery.

CHAPTER II.

THEORETICAL VIEWS ON WHICH THE PRACTICE OF THE DRESSING IS BASED.

THE antiseptic method is founded upon a certain number of theoretical ideas, of which the first and most important is that of the existence of germs.

It was in hospital practice, among the perpetual failures of surgery in a thoroughly infected hospital (Glasgow), that Lister conceived the idea of the method which has made him so famous. He had struggled ceaselessly and in every possible way with insalubrity, and was constantly vanquished by its fatal influences.

Persuaded that the atmosphere about the wounded is especially pernicious in its effects, he thought that these should be attributed to the numerous germs which Pasteur was studying in all the media which surround us. He became a convert to the doctrines of the eminent French chemist. This was in 1865,—that is, a short time after the first publications of that illustrious experimenter. Lister made for himself numerous experiments which demonstrated the presence of germs in the atmosphere, and their influence upon fermentation and putrefaction, and then proposed to enter into a struggle with the disturbing elements. The atmospheric germs, he said, provoke suppuration; they excite putrefaction of the blood and other animal fluids, and, by this process, produce complications in wounds.

Thus the germs or microzymes are, according to him, the cause of the infectious accidents of wounds; and, if they are

destroyed, if their development is prevented, we shall be guarded against the complications which harass surgery.

The germs, like the vibrios which they engender, are infinitely varied : all are not equally harmful ; it is even certain that there are some which destroy those more harmful than themselves. But they exist always in the atmosphere, deposited upon the surface of all objects, and especially in all putrefied and putrescible matters which remain on the instruments, the hands, and the pieces of dressing.

It being impossible to discriminate between the good and the bad, the surgeon should seek the suppression of all. The direct or indirect destruction of all these living beings and of all germs has been practised by Lister.

The result has been the disappearance of the accidents of wounds ; he has seen purulent infection and hospital gangrene absolutely put to flight. Hospitalism is no longer a cause of mortality.

The *ensemble* of conditions practically necessary to the disappearance of the germs put the wounds into a peculiar state, and little by little Lister was led to study exhaustively the conditions of their repair. He very soon saw that to insure the healthiness of wounds not only must the micro-organisms be kept away, but it was also necessary to study certain conditions which are favorable, even essential, to the regularity of the reparative process, if one wished to achieve more perfect surgical results.

These conditions are subordinate in comparison with the prime importance which must attach to the destruction of germs, but yet they play a prominent part in practice.

When the conditions are most favorable to the repair of tissues, as in subcutaneous injuries, there is no suppuration. Contrary to many of the received ideas, it must be admitted that suppuration is not a necessary phenomenon. It implies

a difficulty, an obstacle to repair. It appears when the vitality of the newly formed elements is lowered. It is necessary to seek for the cause of the irritation which is produced, the source of the trouble. Lister recognized the fact that three conditions produce this untoward result : —

Excessive tension in the tissues.

Direct irritation of the living tissues, and the presence of a foreign body.

Direct irritation by the atmosphere charged with germs.

What is excessive tension? It is the phenomenon accompanying all local inflammations, liable to lead to suppuration. In a phlegmon, in a dropsy, in a considerable effusion of blood, there is excessive tension.

Leave an abscess to itself in the process of formation, and you see this excessive tension develop and increase without cessation. Suppuration advances and continues even to the point of solution of continuity. Penetrate to the purulent layer, reach the abscess and evacuate it : it ceases to advance ; the tension disappears ; and one of the causes of suppuration is removed. Then the others show themselves ; but if you can arrest your disease at that point, you will see the suppuration dry up with remarkable rapidity. The opening of the abscess with the precautions of the antiseptic method serves to show the truth of this theoretical view.

We have another distinct illustration in the accumulation of serum beneath flaps which have united by first intention. Close wounds hermetically and let liquid accumulate, and a focus of suppuration will be formed behind the flap. If the wound is in a region liable to infiltration, in the scalp, for instance, there is the starting point of an immense phlegmon. The retention of fluid may be the sole cause. Therefore the draining-off of superabundant fluids should always be pro-

moted by all possible means, and the method of Professor Lister pre-eminently fulfils this indication.

Another disturbing cause of no less importance is direct irritation. Apply permanently to the surface of a wound an irritating or caustic substance, and you will see a purulent secretion form. Mortification, wholly superficial though it be, will induce the immediate throwing-off of the parts. Then, if the irritation continues, granulation takes place. The granulations being irritated give rise to suppuration.

One can observe these facts easily. If we inject irritants into subcutaneous wounds, which, left to themselves, would not suppurate, they do suppurate on the principle of irritation. If an external wound, although it be absolutely aseptic, absolutely secure against the contact of germs and atmospheric products, is dressed with an irritating substance, it necessarily suppurates. If the use of the irritant is continued, the wound becomes granular, the granulations suppurate. The granulation was no more a necessary phenomenon of repair than was the suppuration.

The irritant substance may be a foreign body. Nevertheless, if this foreign body has no direct irritant action upon the living parts, if it is absolutely aseptic, that is to say, unaccompanied by germs, it can interfere in no wise with the phenomena of repair, and will permit normal action to go on all around it, of which we shall give examples when speaking of ligatures which are enclosed in wounds.

We come now to the last condition, the basis, the chief point in the theory of suppuration, — the influence of germs. Let us imagine a wound without excess of tension, without local irritation, without a foreign body. If atmospheric germs are deposited upon this wound, it will suppurate. It is not the action of the air itself which induces this suppuration; for, if we make the atmosphere strictly aseptic, entirely free from germs, the wound will not suppurate.

Doubtless, the purer the air becomes, the less harmful is it to a wound; but it must be perfectly deprived of germs before it can absolutely cease to be a cause of suppuration. The surgeon should be thoroughly convinced of the truth of the germ theory. As the eminent Edinburgh professor has picturesquely remarked, he ought to see germs in the atmosphere as one sees birds in the air.

There is a great difference between this cause of suppuration and the others that we have mentioned. On this account we should be very careful not to put them upon the same plane; we should put forward the germ theory as the pivotal point of the antiseptic method.

Germs have a double action: they do not simply excite the formation of pus, they induce putrefaction; they determine the putrefaction of animal fluids, and thus they are the agents of wound complications, especially of the most formidable, pyæmia.

There are great differences in the nature of the suppuration excited by the first causes mentioned, and that which results from the access of germs to wounds, which led Professor Lister to say, that in the last case, the wound is infected, that putrefaction has set in.

In the first case, suppuration is localized at the defective point, at a point of suture, or at an angle of the wound. Sometimes the pus is pent up, sometimes a little viscid, usually not abundant. The pus corpuscles are granular, distorted. The dressing sometimes has a heavy odor, but it does not have that of putrefaction.

If we suppress the cause, if we relieve pressure at the point where the fluids are retained, if we avoid the employment of an irritant, and order is restored, suppuration disappears. With it immediately disappear the febrile symptoms which accompanied it. The case of the retention of fluids is espe-

cially remarkable in this regard, — that the changing of a tube or the removal of a stitch is sufficient to modify both the general and the local state. I have been amazed at the appearance of a drop of concealed pus; but this having been evacuated, order is completely restored.

But if germs have had access, if the dressing is infected, the conditions are entirely different. The whole wound is affected, pus invades it, — common, laudable pus; and the dressing which is bathed in it has acquired an offensive, putrid odor. Whatever we do now, suppuration will continue, healing will be by granulation, and the rapid reparative process of the antiseptic method is lost. Almost all means will be of no avail to restore the wound to its original aseptic condition. I say almost all means, because we shall see further on that, by certain contrivances, we have come to employ the antiseptic method in the treatment of wounds which have suppurated, in fistulæ, etc. Up to this point it has been my endeavor to indicate the progress of the phenomena and the theory which explains them in the case of a wound made by the surgeon, where the diseased part has been restored with unbroken skin.

In all wounds which have been exposed to the air for some time there exist granulations, the favorite lairs of microscopic organisms in all stages of development.

In order that these wounds may be put into the condition of fresh wounds, and rendered susceptible to the same modifying influences, their surfaces, their granulations, must be destroyed; next, the cavities where they lie must be made healthy by means of powerful antiseptics; and then, perhaps, it may be possible to treat them like fresh wounds, to cause tension and irritation to disappear, to prevent the further entrance of germs, and to allow the wounds to heal without granulation.

If one will read over the principal elements in the treatment of wounds, he will at once comprehend them : —

Destroy the germs or living organisms. Then use antiseptics of various strengths, according to the condition of the wounds. At first, it is prudent to have the antiseptic excessively strong. Then make the atmosphere antiseptic.

At the points where the germs develop, where living beings are evolved, the strength of the antiseptic ought to be increased. If they are lodged in parts where there are sinuities, their destruction will be impossible.

We know that certain conditions are particularly favorable to the evolution of germs, namely, moisture and the presence of putrescible matters, which are capable of furnishing pabulum for the fermentative process. These must be avoided. Pus and urine are favorite media for the evolution of germs. We should take good care not to let them accumulate, and in these cases should use the most powerful means.

There are spots where germs develop very readily, and experience teaches us how to recognize them. In general the healthy organism is a less favorable ground for the evolution of germs than the diseased.

Excess of tension is avoided by whatever insures the draining-off of fluids.

Direct irritation is avoided : —

First, by apposition, which shields the organic elements from all untoward influences, and in some way immediately incorporates them in the organism.

Second, by the exclusion of every foreign body which is septic.

Third, by protecting the wounds from the direct and continuous action of the antiseptics.

I here make note of the apparent paradox that the temporary action of an antiseptic, even if it is caustic, is not to be

considered as a cause of irritation sufficient to produce suppuration. The best proof of this is that the most powerful carbolic solutions and the eight per cent. solution of chloride of zinc, which are genuine caustics, do not hinder the rapid union of the parts which they touch.

If the theory is correct and the preceding conditions are fulfilled, the organic elements ought to preserve their maximum of vitality. In wounds which are fairly sound, in open cavities, repair ought to take place at once without infectious accidents, and without suppuration, just as in subcutaneous injuries. In certain respects, and in certain particular cases, repair ought to be even more rapid than in some subcutaneous lesions, because there is no trouble from excess of tension, such as is liable to occur in the latter.

Practice justifies the theory, as the following pages will prove. Perhaps the facts are capable of some other theoretic interpretation ; but no other could be as satisfactory.

CHAPTER III.

PRACTICE OF THE DRESSING.

THE method of Lister, as we see, is not founded upon a special dressing; it has a complete theory with three principal parts, which point to as many prescriptions of the highest importance. This method may be practised in very different ways, all conforming to these three indications; it holds good always. It is also evident that the procedure of its author is capable of important modifications. To achieve his results, Lister himself developed his work by successive stages. He has made applications infinitely more complicated and less fortunate than those which he commends to-day; and for ten years, while professing the same beliefs, he has little by little simplified and rendered applicable the means which he has advocated. The employment of an antiseptic paste of chalk applied to wounds, the use of costly plasters to effect occlusion, metallic papers, carbolized oil, rapidity of dressing under compresses of carbolized oil or water, all these means have successively given him favorable results; but he only truly achieved practical and complete results after he began to employ the antiseptic gauze and the carbolized spray in the atmosphere of operations and dressings.

Therefore, seeing none but a historical interest in recalling the first attempts, I will give only the procedures which he constantly employs in his service.

I. — *Destruction of germs and living organisms before the operation.*

As I have said before, the destruction of germs is the principal object to keep in view. This would be the only result sought by the method were it not for the accessory conditions which I have mentioned, and to which I shall return.

Germs, which are met with everywhere in the atmosphere, are found all over the surface of bodies which are in it; therefore, everything which must come in contact with a wound ought to be purified of germs, of living organisms deposited upon its surface.

Certain things especially afford lodgment to these living organisms, such as sponges and the common objects on which putrescible matters are most likely to settle.

All these articles should be prepared in such a manner as to make them perfectly innocuous, to deprive them of living beings and of germs; and this result may be obtained by immersing them in a fermenticide bath.

Two aqueous solutions play an important part in the dressing: a five per cent. solution of carbolic acid — the strong solution; and a two-and-a-half per cent. — the weak solution.

The instruments are immersed for some time before the operation in the strong solution. It is well to rub their surface with a linen cloth or a sponge in order to moisten them in their entire extent and in all their crevices.

The sponges are permanently kept in this strong solution. Before using them in the operation, they should be carefully wrung out.

Every object, before it is allowed to touch the wound or its surroundings, should be purified in the same manner.

The field of operation, that is, the site of the operation, and the neighboring parts, should be carefully cleansed with a sponge saturated with the strong solution.

Many precautions have been recommended for this preparation of the field of operation, which do not seem to be indispensable.

It has been recommended to soap the region with the greatest care, and to wash it with ether to remove absolutely all oily matter. It would be bad taste to deprecate this excess of neatness; but since it has been objected to the method that it is too intricate, it is no more than fair to exclude useless complications.

Now, Lister observed that the watery solution of carbolic acid is penetrating. It easily soaks into the layers of the epidermis, and we may be sure that, when the bathing with the strong solution has been done with sufficient care, the region is perfectly cleared of germs. This is the practice which I have seen followed in the Edinburgh Infirmary and in London by the professor, and the excellent results of which I have noted. In my turn I have followed it, and have nothing but praise for it. If the region is very dirty or greasy, one may, as a preliminary, wash it with hot water, which prepares it very well for the action of the carbolized solution.

The action of the strong carbolized water is sufficient for the instruments; the precaution of rubbing them is useful, because the water often runs off of their surfaces and their angles sometimes contain putrid matter. In the case of certain instruments which have irregular extremities, such as forceps, Lister thinks it well to dip them in carbolic oil, containing a tenth part of the acid.

The hands of the operator and of his assistants, which will come in contact with the wound and the instruments, should

be purified in their turn, and every time that they are removed for any cause whatever from the carbolized atmosphere in which the operation is being performed, they should be purified anew. For this purpose the strong, really caustic, solution is not necessary. It is sufficient to dip the hands into the weak solution.

Such are the preparations, the necessary preliminaries of an antiseptic operation, and one can see that it practically amounts to little but attention to the minute details of cleanliness. And, for my part, long before I adopted the application of the antiseptic method, I pursued this course as often as possible, and never had occasion to regret it. The chiefs of the service and the students in our hospitals have often been charged with lack of neatness, for which they should not be blamed, in the actual condition of affairs. It is difficult, in the present circumstances, for a chief of the service to wash his hands, but it is almost impossible for students. As it is in human nature to struggle as little as possible with difficulties, the result is bad. The employment of the antiseptic method changes all this, for even the nurses now have clean hands without trouble.

What is said here of persons is equally applicable to the instruments, and I have come to be quite particular about their cleanliness as regards putrescible matters. We are insured against all danger when they are antiseptically neat. Even the most putrid sponges are purified with great facility, as one can easily observe.

II. — *Destruction of germs during the operation.*

Thus, all the precautions are taken, everything which is to touch the wound is aseptic, deprived of the elements of septicity. But in the course of the operation the atmosphere

will pour upon the wound, upon the operator, upon the instruments, torrents of germs which could not be neutralized at the time. To prevent this, Lister at first sought to the best of his ability to protect the wound from the access of fresh air, operating behind a compress soaked in carbolized oil, and covering the wound as rapidly as possible. All this, however, seemed to him insufficient; and at last he conceived the happy idea of creating around the wound an antiseptic atmosphere. The pulverization of the carbolized water in a powerful stream on the field of operation brought him abundant success.

This manœuvre, to which unjustifiable theoretic objections have been made, is extremely simple; with any one of the pieces of apparatus which we shall study further on it can be made without trouble. It merely consists in enveloping the region of operation, the hands of the surgeon and of his assistants, in the spray furnished by a reservoir of carbolized water, thus creating a pure artificial atmosphere around the wound.

This spray ought to be so fine as not to interfere with or wet the operator, and still be abundant.

The apparatus requires a certain amount of attention. The assistant should be familiar with his work. He should not keep too near the wound,—a mistake which I have seen made. The liquid stream is not intended to have a local action on the wound. It should be so far removed that the field of operation may be enveloped in a cloud. Care should be taken to keep it aimed at the wound, not to send it into the face of the operator, and to accommodate it always to his changes of position, that an antiseptic atmosphere may constantly be preserved. It is well to look out for the stream; it is even necessary, in this respect, to mistrust the steam apparatus, for it is not uncommon to see the

steam rush out, without drawing up the antiseptic fluid, and thus the antiseptic action is lost. Drafts of air should be taken into account, as they displace the pulverized stream and may make it inoperative. These minutiae are somewhat difficult to observe, but are indispensable to the accomplishment of the antiseptic protection. Some surgeons have overlooked the causes of their lack of success, and have blamed the method, when really the fault was their own, in having failed to observe these precautions.

If, from any cause, the spray fails, or if one wishes to give his assistant a rest during a dressing, it is easy to take a compress, soak it in a weak solution, and with it cover for a little while the operating field and the neighboring parts.

There is one direction which it is worth while to remember: irritation of the eyes of the patient by the spray should be avoided; so, during the operation and the dressings, one should habitually cover the face with a napkin or a dry compress.

No other special precautions during an operation need be mentioned. The sponges are wrung out in the weak solution, but when the operation is over, the strong solution should be used for the bathing. This bathing gives the blood and muscles a gray or chocolate color, which is clear and characteristic. It is a capital precaution to take.

III. — *Defence against germs after the operation.*

When this is over, it is still necessary to maintain about the wound an antiseptic atmosphere, and this is the object of the antiseptic gauze, an essential element of the dressing.

The wound should remain in a sort of sheath made by this gauze, which is of the consistency of common tarlatan. It is saturated with resin and paraffin, mixed with carbolic acid;

it gives up the carbolic acid, which is volatilized little by little, particularly in contact with warm bodies. By covering this gauze with an impervious cloth, the carbolized atmosphere is confined about the wound. Moreover, one is sure that the discharge from the wound will traverse the entire dressing before reaching fresh air. If it were otherwise, it would run directly through the gauze to the air. There it would become infected by the entrance of germs, and, if the passage was short, the infection would be propagated across the dressing, although it was antiseptic.

From this arrangement a curious and easily observed phenomenon results. When one removes the dressings within a day or two, there is usually a good deal of discharge. If it happens, for example, to be in a member which rests on a cushion, this, being saturated with fluids, may emit a bad odor. We remove the dressing whence all this discharge has come: it contains more or less fluid; its folds are stained and saturated, but no odor comes from it.

We renew the dressing with the precaution of the spray, washing the wound with the strong solution first, afterwards with the weak, according to our apprehension of too great irritation of the wound. We are guided in renewing the dressing by the amount of discharge: at first, every day, if it is necessary; then every other day, and afterwards less frequently.

In this manner the conditions relating to germs are fulfilled. Though I have mentioned a good many minutiae, I insist that practically it is only necessary to establish the habit; and I can assert that, from the beginning of the trial during my term of service at the hospital, my pupils, as well as myself, took all the antiseptic precautions, and that our dressings, in truth quite infrequent, occupied no more time than was consumed by other methods, always excepting the wadded dressing of Guérin.

Drainage of fluids ; precaution against excess of tension.

As I have said above, the dressing ought to fulfil other indications. The first, and without doubt the most important, is that of drainage. The fluids ought always and from every point to have free vent. Lister always insures this condition, selecting his methods, and giving preference to those which make drainage easy. Then he immediately closes the wound, but leaves several small openings, in which he places drainage-tubes. It may be said that Lister never uses a dressing without employing the tubes of Chassaignac, as he has the courtesy to call them, in honor of our eminent countryman ; but he uses them in a little different manner from that which is customary with us. He does not pass a loop from one point of the wound to another, but introduces a tube into the opening perpendicularly, — long enough to terminate just at the surface. At the outer extremity are fastened two threads designed to keep it in place and to draw it out by at each dressing.

The tube should not be too long ; it should make a canal for easy drainage, but it ought not to strike against the soft parts to irritate them. To introduce it perpendicularly into the passages, which are often very long, Lister uses an instrument which he calls fistula-forceps. This is simply a dressing forceps, with very long and slender blades. If the tube is too long, he withdraws, shortens, and then replaces it. If it projects beyond the surface, it will be pressed upon by the dressing, and will irritate the deep parts, and this must be avoided.

At each dressing the drainage-tubes are withdrawn and washed in a strong solution, to clear them of the blood and puriform matter which they may contain. Each time it is necessary to diminish their length, for the wound heals rapidly

at the bottom, and seems to drive them out. After being shortened they are put back again. Tubes of smaller calibre should be substituted for these, if they are large, and gradually a diminution in size should take place.

When we see that the discharge has entirely ceased, the tube is withdrawn and the external wound closes up. It is always necessary to guard against too speedy withdrawal, for the fluids accumulate very rapidly and make abscesses.

The employment of sufficiently large tubes is imperatively insisted on. Their walls should be very thick, else they collapse, and their capacity for drainage ceases.

It is well to place them beforehand in a vessel of strong carbolized water; the caoutchouc absorbs the carbolic acid well, and remains absolutely aseptic, is even somewhat antiseptic.

There are other precautions necessary to insure drainage. Care must be taken with regard to the position of members, not to raise the stumps as much as is generally done. At each dressing we must make sure that the drainage works well, by pressing upon the lips of the wound. If the existence of *culs-de-sac* is suspected, gentle pressure should be made with a sponge. If points of suture seem too tight, they should be cut; if even at one of them there are manifest traces of inflammation, we must not hesitate to plunge in the point of a bistouri, give exit to the accumulated drops of pus, and put in a small drainage-tube. I have done it with success.

Perhaps there may be a considerable failure of drainage, in which case, besides local tension, one observes a general febrile state. Removal of the constriction is necessary, and must be ample, even if one has to take some stitches afterwards to close the wound. Sometimes the drainage opening is large enough, and then one can profitably inject a little

of the strong or the weak solution, according to the case, to wash out all putrescible matter. But this should be entirely exceptional. I once knew Lister, after having opened a knee for an old dropsy, to find fever the third day, and attribute it to the fact that the chance for drainage was not sufficient. He made a larger opening, and the fever abated.

Precaution against irritation.

Lister seeks for the most rapid union possible, so he always immediately sews up the lips of wounds. This suture is generally made with silver wire, and resembles all interrupted sutures; but in addition he usually takes a deep suture of large silver wire, each extremity of which pierces and is then twisted around a plate of lead.¹ When this is tightened, it bears all the strain; tension and swelling do not show themselves even upon the lips of the wound, in which union is obtained more rapidly and firmly than without the deep stitch.

Lister cuts the wires very early in order to avoid tension of the parts which they hold; but, in order that these may not be altogether deprived of support, he often leaves the wires in place.

There is one rule which it is useful to know: one need not be anxious about the blood which is poured out between the flaps. It is necessary to take great care not to evert a flap or displace a stitch for the purpose of removing a clot of blood; for it will not hinder the phenomena of repair or

¹ The lead plates have applications outside the antiseptic method. Lister especially recommends them in the operation for hare-lip, and I have employed in this case four plates to hold the deep sutures. I cannot too highly recommend this procedure, which always requires close attention. I have employed with it on the outside, an ointment of boracic acid, the formula for which will be found on a subsequent page. J. C.

provoke suppuration, as customarily happens in ordinary dressings.

In conformity to the principles which we have established, the line of union and the free angles of the wound ought not to be reached by irritating substances, under penalty of the formation of granulations and of suppuration. One may, and doubtless should, wash them at the dressing with even strong solutions; but it is undesirable to have irritants remain in contact with the denuded parts. Now, the dressing constantly disengages carbolic acid, and, to prevent its action upon the denuded parts, we employ the protective. It has been quite difficult to accomplish the manufacture of this, which is made of very thin taffeta silk, gummed, covered with copal varnish and dextrine, and thus rendered absolutely impervious to carbolic acid. This material, which is green and very pliable, is placed accurately over the wound; we cut a narrow strip of it, which overlaps the wound a very little, and over this apply the antiseptic gauze.

We come now to the application of the dressing, and the arrangement of its constituent parts.

The Dressing.

The piece of protective is wet in the weak carbolized water to divest it of all germs, for in itself it has no antiseptic quality. It is placed upon the wound, which it should overlap but slightly, in order that the discharge may come as soon as possible to the gauze, the antiseptic substance.

Then we take some pieces of the antiseptic gauze, and, having soaked them in the weak solution, wring them out and place them directly upon the protective. This precaution is necessary in order that the gauze may surely be antiseptic, because it gives up the carbolic acid but slowly,

and, during its exposure to the air, germs may be deposited which it is essential to destroy immediately with carbolized water.

For the same reason, we wet slightly with the same weak solution the surface of the dressing which is applied to the skin.

The last and principal piece of the dressing is ordinarily composed of eight folds of gauze, one upon another. If circumstances require, it is made thicker.

Between the seventh and eighth folds is placed the impervious cloth or mackintosh, with the smooth surface turned towards the wound. The dressing ought to extend a considerable distance beyond the wound, and, if it is applied to a limb, it should reach entirely around it.

The dressing ought to be crossed as much as possible, in such a way that the fluids in draining can find no gap and will be obliged to run over the greatest possible extent of the dressing.

The mackintosh should be placed between the last layers of the dressing, because otherwise it does not lie close enough, and may allow spaces to form under which air may pass, and thus there be developed phenomena of infection, which can be avoided by this precaution.

The dressing should be kept in place by bandages made of antiseptic gauze. This kind of bandage is extremely convenient, does not slip, and is very firm and strong. Its strength is such that in certain resections, particularly those of the elbow, we can dispense with splints, if we apply these bandages properly; they are fastened with pins, or by tying two free ends.

By the assistance of these gauze bandages, the dressing ought to be so well fixed in place that it will not slip. To this end the bandage is moderately tightened.

The better to hold it firmly upon the limbs, Lister usually places outside the dressing at its extremities two rubber straps, which by their elasticity keep the dressing so tight that no leakage or current of air can carry germs under the cuirass thus formed.¹

These are the principal points in the practice of the dressing. But this is subject to a number of conditions according to the circumstances of the case. If the dressing cannot be made broad enough, it should be thicker. We use the gauze to fill up the hollows by which air may rush in, — the axilla, in amputations of the breast; the ear, in injuries of the parotid region, etc.; and the simple or antiseptic wadding around the edge, in all cases where it is needed to complete the closure of a dressing which has a tendency to curl up at the border.

For certain dressings Lister still employs a lint saturated with boracic acid, well prepared in Edinburgh, and very convenient, particularly when the correct application of the dressing just described is impossible.

But for all these details, the experience and ingenuity of the surgeon must come into play; and when he knows the principles, he should seek for everything which will assist him in their application.

Among the accessory means I will give a description of the compression with sponge which Lister recommends.

When, in the course of an operation, he has made a very large wound, after closing it, he thinks it well to exercise some compression upon the sac thus formed; and for

¹ The application of the rubber straps here mentioned is limited practically to dressings on the limbs. When the wound is on the trunk, a long, elastic bandage may be used to confine the upper and lower borders of the dressing in the most desirable position, and yet not be so tight as to interfere with the necessary movements of the thorax and abdomen. The ordinary suspender-webbing answers admirably for this purpose.

the first dressing, he applies over a piece of protective a sponge of convenient form, soaked in strong carbolized water and well wrung out ; over this he puts the gauze dressing and the bandages according to custom. The sponge makes effectual compression, and besides absorbs and neutralizes the fluids which are discharged in abundance. In the subsequent dressings, this practice is usually unnecessary. We should always be careful to place a layer of protective between the sponge and the skin, for without this a kind of blister would be formed, and the patient would suffer intensely from burning. This is one way of practising compression upon wound cavities.

All the ligatures have been enclosed in the wound, as I shall explain presently, and the dressing is adjusted. What remains to be done for the patient ?

We should advise such a position of the wounded part as will favor easiest drainage. Generally the dressing is renewed at the end of twenty-four hours, less frequently at the end of forty-eight.

Although the extent of the wound may be small, there will be a considerable discharge of serum. This immediate discharge, abundant after all large operations, is perhaps greater after those which are performed by this method, probably by virtue of a special action of carbolic acid upon the tissues.

In uncovering the wound one should take the same precautions as before with respect to the atmosphere, the hands, and the instruments. Then he will notice if the parts are stretched, and if they are not, the tubes are left in place for this first dressing ; but, if they are stretched, it is necessary to withdraw the tubes to empty them of clots ; and if fluids have accumulated, they are forced out by gentle pressure.

The wound or stump is washed lightly with the strong solution, unless it is irritated, even to a slight extent, in

which case the weak solution should be used. The tubes are then cautiously replaced. The sutures are carefully examined, that they may be loosened if it is necessary. Then, as at the original dressing, we apply —

First, the protective, after having dipped it in the weak solution ;

Second, some pieces of gauze moistened in weak solution ;

Third, the dressing, — eight layers of gauze, with the impermeable cloth between the last two layers ;

Fourth, the gauze bandage.

This dressing ought to extend a good deal beyond the region of operation.

It is not an infrequent dressing ; it is applied often at first, less frequently afterwards. The especial guide for its removal is the amount of discharge. The existence of pain would also indicate its removal.¹

Whenever the discharge appears at the edge of the dressing and stains it, prudence requires us to remove it in order to avoid all chance of the propagation of putrefaction.

If any odor is detected, the dressing should be absolutely distrusted, for it should have no odor at all.

The perusal of this work will show that there are many modifications to be introduced according to the case ; however, to give a very striking example of what may be done, I may be allowed to quote the report of one of my oldest

¹ After almost any operation there is likely to be some pain, even if the wound has been subjected to the anæsthetic influence of the carbolic spray ; but there is no occasion to renew the dressing on this account, unless the suffering is considerable and persistent.

Another circumstance which imperatively demands the removal of the dressing and the careful inspection of the wound is that harbinger and attendant of septicæmia, — the rapid rise of the temperature, and its continuance at a point much above 37.7° C.

cases, published in the Journal of Practical Medicine and Surgery, for February, 1876. This will necessitate some repetition, but it seems to me typical enough to aid those who wish to apply the method. I give it as an ordinary case, in which I think it would have been possible even to abridge the treatment some days.

A man, aged forty-two, entered the hospital during my service for treatment of a vicious cicatrix of the left leg. He had been burned two years before by melted zinc, and the skin of the whole leg was so completely destroyed that one could see nothing but a vast, persistent ulcer, suppurating and bleeding. This had also produced a permanent flexion of the leg upon the thigh, which had not yielded to several attempts at extension and division of the ham-string tendons in other hospitals. Sinuses, discharging pus profusely, kept breaking out on the internal aspect of the thigh, and he urgently entreated to be relieved of this useless and dangerous member.

It was easy to see at the first examination that the limb could never be entirely restored. Still I did not want to accede to his desire for an amputation of the thigh; it seemed to me that the sinus might be healed, then the leg removed at the upper third, and that he might walk well upon the flexed knee.

I first treated the sinus of the thigh; the inflammatory phenomena abated as the abscess disappeared, and I resolved to proceed to amputate at once.

On the tenth of November, 1875, I amputated the leg at the upper part by the circular method.

I had great difficulty in finding enough skin to make even a scant covering. By sawing the bone at the highest possible point, I was just able to close the wound.

I applied five catgut ligatures to the vessels, and then

sewed up the entire wound, excepting the two extremities. I took also a deep suture with lead plates at each end of the wire, to assist apposition.

At each side of the stump was inserted a straight drainage-tube, fastened with a thread to keep it in place. The dressing was placed over all.

The operation was performed with all the precautions suggested by Professor Lister, which are thus summed up:

I washed the operating field with a strong carbolic solution (one part of glacial acid to twenty of water).

The instruments and sponges were placed in the same solution.

The hands of the operator and assistants were washed in the weak solution (one part to forty of water).

A spray of the same solution was thrown upon the field of operation from first to last.

Catgut ligatures were used and cut short in the wound.

An occurrence worthy of consideration marked the end of the operation. I did not employ the system of Esmarch to prevent bleeding, but, as I am accustomed to do, made compression at the upper part of the limb with an india-rubber band. In similar cases it often happens that there is indefinitely prolonged oozing of blood from the entire surface of the wound. Following in this the practice of Professor Lister, I proceeded with moderate speed, and inserted the sutures.

Over all was placed the dressing: first the protective, then the antiseptic gauze, last the mackintosh or impervious material.

I renewed the dressing the next day. There was no change; still there had been considerable discharge into the dressing, which was odorless. The stump being distended by the effused blood, I loosened the deep suture; I removed

the drainage-tubes to cleanse them, taking good care to evacuate the effused blood, and, the stump having been washed with the strong solution, the dressing was replaced for forty-eight hours.

On the thirteenth of November, I removed the dressing. This time there was little discharge; there was a small amount of brown liquid in the tubes, which I withdrew to wash and shorten. The stump, which was smaller and not changed in color, was bathed in the strong solution, and the dressing was renewed.

On the sixteenth of November, I again renewed the dressing; I took out the stitches, the union was perfect; I removed the tubes and shortened them considerably. I found in the dressing and in the tubes a few drops of a puriform liquid, which was without odor. I repeated the bath with the strong solution.

As all the conditions had been perfectly complied with, I was annoyed by the presence of these drops, which, though not pus, were at least puriform, and I reflected on their possible origin. I thought that it might be attributed to excessive irritation of both extremities of the wound, and I resolved not to use the strong carbolic solution in renewing the dressing.

At the fourth dressing, on the twentieth of November, the appearances were the same; the liquid in the tubes was similar. I shortened the tubes very much, and contented myself with washing with carbolic water of one part to forty.

At the fifth dressing, on the twenty-fourth of November, I only found some drops of cloudy fluid, the dressing being hardly stained.

At the sixth dressing, on the twenty-ninth of November, I withdrew the drainage-tubes, which had been shortened to

their minimum the preceding time, and washed with the weak solution.

Five days after, the fourth of December, when I took off the dressing, it was not moist, everything was healed, and I redressed the wound only because I had the materials prepared.

On no day did the patient have real fever. The temperature on the first nine days was as follows: first day, evening 38.2° C.; second day, morning 38°, evening 38.3°; third, morning 37.4°, evening 37.8°; fourth, morning 37°, evening 38.4°; fifth, morning 37.2°, evening 38.4°; sixth, morning 37.2°, evening 37.6°; seventh, morning 37.2°, evening 37.4°; eighth, morning 36.8°, evening 37°; ninth, morning 36.6°. After this the morning temperature generally ranged from 36.4° to 36.8°, and that of the evening never exceeded 37.4°.

Here was a man entirely cured in twenty-four days; and still there was nothing extraordinary in the case, for the phases of repair were exactly those indicated by Professor Lister. The wound, maintained in apposition, gradually closed at the two extremities; there was an ordinary amount of discharge. The catgut ligatures remained in the stump without creating any irritation.

The blood which was effused into the stump behind the sutures, and the presence of which I can prove by my internes, and by the students who followed my service, did not putrefy and did not interfere with the process of repair, as it always does in other methods of dressing, as all the advocates of union by first intention acknowledge.

There was a curious incident, which seems to decidedly support the Lister theory. Having seen that a puriform liquid was formed, I supposed that it was caused by excessive irritation of the wound from a strong solution; I employed a

weak solution, and, after the next dressing, there was no more discharge.

There was no suffering. His temperature being but slightly elevated, the patient had only a mild traumatic fever, and this conforms well to the theory.

So much for the physiological process. Now look at the result as it concerned the patient. In twenty-four days a man in a deplorable state of health recovered entirely from an amputation of the leg at the upper third. The sinus of the thigh, which was discharging pus, cicatrized spontaneously. There was no suffering. There were only six dressings.

Eight days afterwards this man was walking about on a wooden leg, and has had no suffering since ; I heard from him two years after.

CHAPTER IV.

THE DRESSING OF OLD WOUNDS WHICH HAVE OR HAVE NOT FISTULES. — WOUNDS IN THE NEIGHBORHOOD OF NATURAL OPENINGS.

SURGERY is not simply operative, nor is it practised solely for people who present themselves with unbroken skin. Is it possible, when a wound has been exposed to the air, or when it has suppurated, to purify it sufficiently to make antiseptic treatment successful?

Yes, certainly; and this answer applies to both classes of cases, — recent wounds, in which granulations have not yet formed, and wounds which have been suppurating for a longer or shorter time.

A recent wound, without granulations. — If it is fresh and still bleeding, it will suffice to give it a bath in the strong solution. If it is very tortuous, or if it has been exposed to the air for a long time, we employ a still stronger solution, ten parts of carbolic acid to one hundred of water.

We may even use an alcoholic solution, containing twenty parts of carbolic acid to one hundred of alcohol. We can purify it sufficiently, as large wounds in bones, complicated fractures, which have received the advantages of antiseptic surgery, abundantly testify.

In case this strong alcoholic solution is employed in very tortuous wounds, as it is a powerful caustic, it is well to resort to a special operative procedure. Instead of injecting it freely and at random, it is a good plan to guide it into the wound by the aid of a sound or a caoutchouc tube fitted to

the end of a syringe. By injecting thus, the quantity of the liquid is graduated at pleasure, and there is no forcing, no tearing of the areolar tissue, no spreading on to or burning of all the surrounding parts.

Wounds which have been suppurating for a longer or shorter time.—When, however, established suppurations, old wounds, and particularly fistules which remain in the operating field are in question, antiseptic surgery is untrustworthy. It probably happens in such cases that the granulations retain accumulations of germs which cannot be affected by the fermenticide action of even a very strong carbolic injection; and, little by little, the wound, which at first was exempt from suppuration, is invaded by it, as with an ordinary dressing.

Lister had experienced frequent failures, when he saw Volkmann, of Halle, employ a method which has since given him the best results.

It consists, in brief, in restoring the wound to its primitive conditions of vitality. It is a veritable freshening practised upon the entire surface, even into its most remote recesses.

To bring back to its normal state a wound which has suppurated, we must carefully destroy all the granulations, all the fungous excrescences, which are found upon its surface; then it is particularly important to penetrate into the fistulous passages and extirpate the granulations in them.

This is very difficult to accomplish, but it can be done with the sharp spoon, which Volkmann has invented. This is a little cup of steel, very narrow and made in various shapes, mounted upon a long stem, and having a sharp edge. This is carried into the fistulous tracts, which are then scraped, and the detached granulations are brought out. Thus the passages are swept, as it were, in their entire extent. This manœuvre must be insisted on, as a means of destroying the

greatest possible quantity of granulations. Upon the wound and in the fistules thus made bare, it is necessary to exert an antiseptic action. For this purpose recourse is had to a powerful disinfectant and caustic, reserved for these cases, the chloride of zinc, of which we inject an eight per cent. aqueous solution.

This injection is gently thrown into the fistulous passages, without rupturing their walls, so as not to introduce into the areolar tissue a liquid which will produce gangrene.

Its action would be uncalled for in a widely open wound which had suppurated at one point only, if we could excise and detach all that had suppurated.

By the aid of bent scissors I have succeeded in denuding the internal surface of quite a large portion of a small flap of an amputation of the thigh, the upper sinus of a white swelling of the knee. All the parts having been excised, the flap was carefully washed with the strong carbolic solution, and the wound was closed without delay.

But when we come to fistules, to burrowing sinuses which have suppurated for a long time, the action of chloride of zinc is indispensable, and it is almost always efficacious.

I have often practised this method, and have seen the most remarkable results from it. I have been able, for example, to render completely aseptic an immense purulent sac, which filled the whole buttock of a girl, producing an interminable suppuration. I laid open a part of the fistula. The washing out brought away a handful of fungosities and some *débris* of bone. I then injected chloride of zinc, united the parts with three points of suture, and put in a drain. Healing was accomplished in a few days, and an examination of the patient months afterward revealed no return of the disease.

One can hardly imagine how favorable to the healing pro-

cess is the condition in which surfaces are put by this kind of preparation. Perhaps it is best seen in resections of the joints.

When the wound is thus cleansed it is in the condition of a fresh one. As such it should be treated, and will unite according to all the rules. No different directions are required from those which are needed in the case of a recent wound.

The antiseptic power of chloride of zinc is such that it should be employed in these cases and in all in which doubts of the efficacy of carbolic acid are entertained. Socin, of Bâle, it is said, goes further, and washes recent wounds with the zinc solution. We know that as soon as they are covered with a delicate, white eschar, rapid union will easily take place. I have often employed this procedure, and like it for some large operations; but I prefer to avoid it whenever it is possible, because the irritation from it is greater and the pain which follows the operations is very severe.

Wounds in the vicinity of natural orifices.

The action of chloride of zinc, which renders organic substances imputrescible, is such that it permits us to make a dressing which is incompletely antiseptic, but still very valuable whenever the aseptic dressing is not applicable in its entirety. This is the case, for instance, in operations about the natural openings, — the anus, the mouth, etc.

These operations are made without the spray, after preliminary washings. After the operation and before the dressing, the lips of the wound are carefully impregnated with an eight per cent. aqueous solution of chloride of zinc, and then united. A drain is inserted, if possible, and then the wound is protected by folds of carbolized gauze, or better by linen saturated with boracic acid ointment and by borated lint.

The baths are of carbolic acid or chloride of zinc ; but we must remember that the antiseptic action of the latter lasts at least two or three days, and the better way is to leave the dressing in place for that time without disturbing it. Then a carbolic acid wash is used, and the dressing is renewed. If any portions of the wound are not healed, we touch them anew with the chloride. This method may be infinitely varied and accommodated to the requirements of each wound.

I cannot, however, end this chapter on the treatment of parts which have suppurated without remarking that Lister, when he finds diseases which have given rise to suppuration of a bad nature, even before the contact of air, employs the chloride of zinc. I have seen him, for example, in the case of a young boy, attacked with osteomyelitis of the tibia, lay open the periosteum, and separate it carefully, especially where he could see drops of pus. Then, upon all the gaping parts, opened from the knee to the lower third of the leg, he freely poured a solution of chloride of zinc ; and this operation was repeated the next day at those points where swelling still existed.

The reaction was less active than one would have expected, and this child, who presented typhoid symptoms of the most menacing character, completely recovered, and preserved his limb intact.

I myself have used the chloride successfully, as I shall explain when treating of abscesses.

CHAPTER V.

BORACIC ACID AND UNIRRITATING DRESSINGS.

IN certain cases, where, on account of extreme sensitiveness of the skin, carbolic acid produces a kind of eczema, and in others, where there is little to be discharged by drainage, antiseptis may be obtained very excellently by the aid of boracic acid. It should be remembered, however, that this is a far less powerful agent than carbolic acid, and that, in consequence, much greater care is necessary in using it.

Wounds are prepared exactly as in cases where carbolized gauze is employed, by a bath of carbolic acid. Then layers of boracic acid lint are applied directly over the sutured surface, the undermost being wet in a saturated, aqueous solution of the acid, — four parts to one hundred. The protective can be dispensed with, as the boracic acid is hardly at all irritating; but in some cases I employ it just the same.

A sufficient thickness of lint having been applied, the impermeable layer is added, and then the dressing is firmly secured. If there is a considerable amount of discharge, the dressing must be renewed very often; but ordinarily we employ this kind only when there is a moderate drain, and then it has to be renewed but rarely.

Instead of a dry dressing, it is frequently preferable to make use of one in which boracic acid ointment is an element. For this purpose, a strip of lint is smeared with a layer of this salve, and is applied directly to the wound, and over this are placed the folds of boracic lint, as has been already described.

This unguent of boracic acid is very mild and unirritating, and, in erythema, it is of conspicuous service. In fact, I have often applied it all around the wound, while using the antiseptic dressing of carbolic acid, and find that, in addition to the antiseptic rôle which it plays, it has a kind of protective action upon the wound. This is an especially good dressing in all plastic operations. It is particularly useful at the last part of the treatment of large wounds, when discharge has nearly ceased, and only superficial parts remain to be healed.

The dressing of wounds which cannot be closed.

If it is not practicable to bring the lips of a wound in apposition, the antiseptic method may be used with profit, without, however, getting the benefit of one of its most important advantages.

In such a case, it is best to close the wound as far as possible, and shield with protective the portion which cannot be united. At each dressing, scrupulous care should be taken not to cause irritation by the use of a strong solution in washing.

If the direct, irritant action of the carbolic acid in the dressing is feared, that part of the wound may be dressed with the ointment of boracic acid and plentifully covered with the lint.

CHAPTER VI.

THE TIME WHEN THE ANTISEPTIC DRESSING MAY BE OMITTED.

THERE is one condition of success of so great importance that it is desirable to devote a special chapter to it. It has been advised to omit antiseptic precautions as soon as the dangers which have menaced the life of the patient have disappeared, and not to continue them to the very end of treatment, because the use of carbolic acid has been thought to retard the last steps of the reparative process. This, however, is a deplorable mode of procedure.

Until cicatrization is perfect, until the repair of the wound has been absolutely finished, we should persevere in the antiseptic protection.

If we desert a wound too soon, the surface, even though it be very small, suppurates, and this prolongs by just so much the work of healing. If there happens to be an opening into the interior, a part of the tract of the tube unclosed, suppuration is certain to occur; if there is an extremity of bone at the bottom, we have osteitis, partial necrosis, and persistent fistulæ, just as if an ordinary dressing had been used. In a foreign hospital, where two surgeons applied the Lister dressing correctly enough, I have seen a series of amputations. In one service, the patients had pain, redness, swelling of the bone, and fistulæ: in this service, as a rule, the dressing was omitted after a little time. In the service of the other surgeon, the appearance of the stumps was perfect, there was nothing whatever to criticise: in these cases, the dressing was continued until cicatrization was complete.

It is not always necessary to maintain precisely the same dressing. In the first part of the treatment, the discharge becoming less and less abundant, according to the progress of repair, the dressing is changed more and more rarely. Later any convenient dressing may be used, provided the principles of antiseptics continue to be followed.

Thus, boracic acid lint is very useful in the latter stages of the cure. It can be put directly on the wound, or separated from it by protective. Before it is applied, it is well to wet it in a concentrated solution of boracic acid. If there is very little discharge, we can dispense with the impermeable layer about it; but, for my part, I prefer to continue its use. It gives more security, and prevents the too rapid drying of the secreted fluids.

At this period, the carbolized wadding, or better still the salicylic wadding, or the prepared jute, can be used with advantage. In a word, as the protection of the wound is much easier at this time, we have far more liberty in the selection of means. When healing seems to be accomplished, if there is any doubt about some corner of the scar which is covered with a scab, it is wise to apply a final dressing, which should be left in place without renewal.

In the course of treatment, the management of the tubes is sometimes difficult. As a general rule, after the first days they should be much diminished in size. In fact, from this time the discharge becomes inconsiderable; but before finally withdrawing the tube, we must make sure that there is no chance for the accumulation of fluids in the deep parts.

Many surgeons at the beginning of their antiseptic practice leave the tubes in the wound too long, and thus cicatrization is retarded.

CHAPTER VII.

THE SUTURE AND CLOSURE OF WOUNDS. — SUPERFICIAL AND DEEP SUTURES. — COMPRESSION WITH CARBOLIZED SPONGE.

THERE has been a great deal of talk of late about the suture, and it has even been asserted that the especial kind of suture is the most original thing in the Lister dressing. One must be very ignorant of the method to make such a statement. Neither the single nor the double suture is an integral or necessary part of an operation. There are indications for it, it may be employed, and may be very useful with particular precautions.

The more exactly and carefully the suture is made, the more rapidly will the wound heal. Nevertheless, it may be truly said that, with the antiseptic method, union is so easy that excellent results are obtained, even when coaptation is not perfect.

Ordinarily a superficial suture is made with metallic thread, and Lister usually employs also the deep suture, but this is not his invariable practice. I have seen him make a number of operations without resorting to it in any way. Every surgeon of much experience will easily understand the reason of this. The best of even superficial sutures compresses and strangles the tissues; and, if it is not watched, little points of suppuration are formed. Lister habitually cuts the sutures early in order to avoid this complication.

He uses coarse metallic thread, particularly in making the deep suture; but various other materials may be employed, such as carbolized silk, catgut, horsehair, and *crin de Flor-*

ence. Although some imitators of Lister advise the hare-lip suture, I consider it defective and useless, and in my anti-septic operations have given it up entirely.

A very striking fact to the surgical mind is the freedom with which the suture may be used. The time has gone by for discussion of the question of closing stumps after amputation. The suture is made boldly in wounds of every kind—in amputations, wounds of serous membranes, of articulations, of the scalp. I have used it after removal of a sebaceous cyst of the head; I have employed it upon the scalp after ablation of a lipoma; but I have made it oftener after opening immense abscesses, and have obtained perfect reunion of a portion of the opening after reducing the aperture of exit to its necessary dimensions.

Apposition is accomplished very easily, and we pay no attention to certain precautions which were recommended in former times. The presence of ligatures in the wound gives no concern; we care very little about removing every drop of blood, for what we desire is the asepticity of the wound—its surgical cleanliness,—and this is not interfered with by the presence of little clots. If the parts have been carefully washed with the chloride of zinc solution or the strong solution of carbolic acid, we shall obtain excellent reunion of surfaces which seem to present real, though minute, sloughs. We get it, also, when, the circumstances not necessitating so powerful an antiseptic action, we use weak carbolic solutions, or even the solution of boracic acid.

The superficial interrupted suture is the most convenient and the easiest to make. I usually take the stitches more or less deeply, according to the depth of the wound.

When there is difficulty in bringing the superficial parts in apposition, repair is greatly facilitated by inserting some deep sutures. Lister advises their use as follows:—

He takes a needle threaded with coarse silver wire, and, introducing it at some distance from the wound, he thrusts it to the very bottom of the solution of continuity, then carries it from within outward on the other side, and brings it out at a point opposite that of entrance, and equally distant from the incision. Then he twists each end of this wire around a leaden plate, which serves to keep it firmly in place. The application of the first plate is much easier than that of the second. In order to secure this, it is necessary to forcibly support the lips of the wound, which tend to gape. We are thus sometimes enabled to bring together parts so far separated that at the first glance apposition seemed impossible.

The suture being made, it must be protected. Drainage should be carefully provided, not only because accumulation behind the suture tends to break it mechanically, but also because excess of tension causes inflammation and suppuration, which would destroy the young products by which repair is effected. This result is easily obtained by the superior method of drainage pursued by Lister.

The suture, however, needs this adjuvant only at the first. The presence of a deep stitch demands particularly careful drainage, without which it forms a decided barrier to the discharge; and this is one of the principal reasons for employing it only when it is clearly indicated.

The suture needs to be protected from the irritant action of topics, and many fail in their use of it by disregarding the theory of the protective, which they neglect to apply. Others, always with some special intent, cleanse the wounds, and rub the surfaces with antiseptic liquids; and their superfluous neatness only serves to prevent healing. Still others, entertaining the same views, inject by the tubes liquid antiseptics, which they think will favor healing and prevent accidents, and they get the diametrically opposite result—

remarkable slowness in the reparative process, and failure of union at one or more points.

The deep suture is necessary only when apposition is impossible or difficult, and should be continued the shortest possible time, as it is very likely to induce deep suppuration. I have seen extensive phlegmons result from deep sutures which were nearly useless, and which were allowed to remain unnecessarily. Even the superficial suture ought not to be left too long, and Lister, as I have said, takes the greatest care to cut at an early day all or part of the stitches. He cuts them without removing them immediately, for they can still give some support without irritating or compressing the edges of the wound, and can thus be of use.

If, at the level of the deep stitch, there is a little accumulation of fluid, let out the drop of pus with the point of a bistouri, before it provokes the ungluing of the flaps.

Compression has been advocated as an indispensable adjuvant of the suture, and it is doubtless useful when there is a large cavity to be filled. Lister recommends an excellent procedure, which consists of compression with pieces of sponge which have been soaked in strong carbolic water.

The employment of folds of antiseptic gauze, skilfully applied, is also very useful; but forcible constriction is entirely superfluous. I have had excellent results in some cases where compression had been so imperfect that the space under the flaps had filled with blood, and in others where the violent pain of inflamed parts, such as articulations, rendered all compression impossible.

What shall be the material of the suture? Whatever it is, it is necessary to purify it and soak it in a strong carbolic solution. For most cases I prefer silver wire.

Lister often uses horsehair.

Carbolized silk is very manageable, and certain English surgeons employ it exclusively.

Catgut is a good material for suture, but it is not free from objections. It swells too quickly, and thus occludes the orifice made by its passage, and prevents the escape of liquid along the thread.

Le crin de Florence, the secreting organ of the silkworm, seems to be an excellent material for suture.

Lister is in the habit of putting the stitches quite near together. It is best to use a needle of a size a little larger than the thread requires, as by this means there is less irritation in its track.

For the introduction of the catgut suture, it is convenient to have a special needle, like that of Charrière, or of Bruns, or, what is in my opinion the best of all, a modification of the latter suggested by Reverdin, of Geneva. Each of these needles has a somewhat spear-shaped point, with a notch on one edge, which is closed by a sliding rod. The needle is thrust through the lips of the wound, the notch is opened by the withdrawal of the rod, the loop of catgut is inserted, the notch closed, and the needle drawn back.

CHAPTER VIII.

DRAINAGE.

As I have already said, drainage is of paramount importance. The materials used are various, but as yet I have found nothing better than the tube of Chassaignac. However, I consider tubes of silver, aluminium, or glass very valuable in certain cases, and superior to those of caoutchouc; but as satisfactory specimens are not in the market, I will devote no space to a description of them.

Three principal modes of drainage are generally employed: with the perforated caoutchouc tube of Chassaignac;¹ with catgut, as taught by Dr. Chiene, of Edinburgh; and with horsehair, as proposed by White.

Whatever may be the material employed, it is indispensable to understand certain conditions of drainage. Wounds which have been touched by the powerful antiseptics, carbolic acid or chloride of zinc, discharge a considerable quantity of serosity, which thoroughly saturates the dressings of the first twenty-four hours. It is particularly for this discharge at the outset that drainage is required, and, this being provided for, the quantity of the fluid which is poured out diminishes rapidly, and soon drainage is unnecessary. If the surfaces of the wound are irritated anew, a fresh discharge is provoked.

¹ Excellent and very inexpensive drainage-tubes may be made easily of ordinary rubber tubing, which can be cut into pieces of any required length. The holes should be of large size, and may be made very nicely with ordinary scissors.

As these liquids are serous, slightly thick, tinged with blood, or only turbid with altered leucocytes, their discharge is easy, and one is surprised at first to see that a drain of relatively small size is sufficient to empty a large cavity. This is illustrated in the case of a drain placed upright in a large articulation, even when the liquids must run against gravitation.

But, although drainage does not require much apparatus, at least what it has ought to be efficient and operate in the following manner:—

Lister does not place a drain in a wound from one end to the other, as Chassaignac has taught, but inserts one or more perpendicularly from the surface to the bottom, thus making channels between the apposed surfaces. But these canals are incomplete, they are *culs-de-sac*; and, as healing takes place from the bottom towards the surface, the tubes are driven out.

Every day the drain is withdrawn to be cleansed, and is shortened to prevent the inner extremity's irritating the parts which are healing.

In inserting the tube with the Lister fistula-forceps, no force should be used, lest it excite irritation, and, for the same reason, it should not project beyond the surface and lift up the dressing. A thread is fastened to the free end for the purpose of drawing it out.

As it is important to avoid all irritant action in the deep parts of the wound, Lister carefully abstains at the time of the dressings from injecting antiseptics through the drain. These retard healing by partially preventing the union of the flaps, and exciting suppuration.

He even goes further. Ordinarily, on the day after an operation he considers it advantageous to withdraw the drain, as he does in all following dressings, in order to cleanse

it. But when there has been an outpouring of blood, and the tube is embedded in the clot, he advises not to extract it at the first dressing. This permits the clot to organize and to assist in the repair. If, by the withdrawal of the tube, the clot is broken or irritated, it is discharged in pieces with the fluids of the wound. After the clot is organized, it acts as a sheath into which the tube can be returned when it has been cleansed.

Great attention should be paid to the selection and insertion of the tubes. They should be large and strong, and so placed that their lumen may not be effaced; they should have no elbows, and should not be pressed by any point of suture. In order to fulfil these conditions, it is well, at the time of the operation, not to insert them until the suture is nearly complete.

In the subsequent dressings, not only is the tube to be shortened, but it is to be superseded by tubes progressively diminishing in size.

I am in the habit of using two tubes of small calibre side by side, instead of one of large size. If need be, I employ a fagot of little tubes, and this method presents several advantages: in the first place, the capillary oozing takes place upon a more extensive surface, and drainage is accomplished more easily; then, on the next day, one may remove a single tube, and, if the discharge is moderate, leave it out, or, at any rate, stop using it after the second or third day; finally, tubes of moderate calibre are much more easily introduced, even when there is quite a number. We may use different sizes in the same bundle.

For the introduction of tubes the fistula-forceps is very valuable. The tube being seized in the direction of its axis is easily inserted. Lister sometimes even avails himself of the almost sharp extremity of the forceps to make

counter-openings through which he draws the rubber tube.

Drainage with catgut was proposed by Dr. Chiene, of Edinburgh, who insisted upon the superiority of a drain which would not need to be removed and which, after it had performed its work, would be absorbed. It consists of from six to twenty pieces of catgut in a bundle, which is used instead of the tube of caoutchouc. The extremities are allowed to pass slightly beyond the surface of the skin. The fluids filter by capillarity along the threads, and after some days—the time varying according to the number of threads employed—the drain is absorbed, and reunion is accomplished.

By this method the deep irritations caused by displacements of the tube are avoided; and, far from hindering repair, the foreign body in a way assists it. Reunion is effected much more rapidly, and consequently recovery is less protracted. An interesting work by Dr. Jules Boeckel, communicated to the Surgical Society, gives support to this view. He cites many very remarkable observations made in cases of large amputations.

I think, indeed, that this method may be applicable in some cases, but I do not consider it as sure as ordinary drainage. Having tried it a few times, I have noticed that it may easily occasion unpleasant accidents. The catgut being put in place immediately swells, and, if the wound is a little tortuous, or the orifice of exit of the drain rather narrow, the opportunity for the escape of fluids is insufficient, and it becomes necessary to withdraw the drain.

In short, I believe that this kind of drainage possesses real advantages as regards rapidity of cure, but it is somewhat defective as regards security. I am more favorably disposed towards drainage with horsehair, advised by Mr. White, of

the Nottingham General Infirmary, and adopted more recently by Mr. Lister.

This consists of a bundle of well-washed horsehair, saturated in the strong carbolic solution. The deep extremity has a hair tightly wound about it and tied. These drains are used just as are the others which have been described. The fluids filter by capillarity along the hair, which does not change in size or become clogged, and thus gives excellent drainage. If it does not work well, it may be removed and reinserted, and it may even be diminished in size without removal, by withdrawing a number of hairs. I have seen Lister use horsehair in almost the same conditions as the tube of rubber, over which it has the advantages of draining as well when bent as when straight, and of not contracting the bad odor which the caoutchouc tubes sometimes acquire.

Admitting that this material is not generally employed, still it is useful to know of it, for it is found everywhere, and may be very serviceable, particularly in the country, where the dressings must often be made from whatever is at hand.

While on this subject, I may mention that wounds of small extent may be sufficiently drained by any substance which is impermeable on account of a smooth surface, such as bits of taffeta, gummed cloth, rubber thread or ribbon, etc., and in certain cases it is desirable to employ one of these substances. I emphasize this, because I have drained with all of them; fine layers of rubber in particular have rendered good service in minor operations. In bundles they may sometimes take the place of a large drain.

Recently there have been made absorbable drains, perforated and channelled like the others. I have no personal experience with them, but I have doubts about their coming

into general use, since drainage by the resisting tube has so many advantages.¹

The surgeon should aim at reducing the time of drainage to a minimum. M. Jacques Reverdin recently informed me that for some time he has derived advantage from greatly shortening the period of drainage. He more frequently refrains from replacing the drain after its removal.

¹ The drainage-tubes referred to were introduced by Neuber, of Kiel, and are made of decalcified bone or ivory. They disappear by absorption after they have performed their work. Their advantages are those claimed for the catgut drains. Esmarch and others have used them extensively, and are enthusiastic in their praise. The method of preparation is as follows :—

Into a solution of one part of hydrochloric acid in two parts of water put the drains which are to be decalcified, and let them remain for ten hours. Then remove them and wash them in a five-per-cent. carbolic solution, and preserve in ten-per-cent. carbolic oil.

As these tubes are quite costly, it has recently been proposed to use the shafts of the long bones of chickens for this purpose.

CHAPTER IX.

THE ANTISEPTIC SPRAY.

THE production in the atmosphere in which the operation is performed of a spray of carbolized water to protect the wound from the torrents of germs which the atmosphere is constantly pouring upon it, and which are peculiarly a menace in hospitals, constitutes a great advance upon Lister's first attempts, in which rapidity of operation and of dressing under an oiled compress afforded only partial protection.

This procedure consists in enveloping the region of operation in a cloud of pulverized carbolic acid. It is not intended, as many suppose, to cover the wound with a fine shower of the acid; and it is even well to remember that this rain, if prolonged and too directly applied, will irritate the integument of the patient and also the hands of the operator.

The spray is intended to destroy the germs and bacteria in the air of the operating region. Does it act by directly killing the germs? Does it act by driving them upon the antiseptic soil where germicide washes are flowing? It is difficult to state its mode of action, but it is certain that it absolutely changes the conditions of operations, and no experiments made in circumstances different from those in the operating room can avail against the actual experience of surgeons who have tried antiseptic surgery with and without the spray.

Now, experience is very clear on this point. We have

been able to have uniformity in the results of operations only since the introduction of the spray; operations which open great cavities, the recesses of which are inaccessible to washes, — gastrotomy, herniotomy, the opening of large abscesses, arthrotomy, — are dangerous and often fatal without the spray.

The importance of the spray is somewhat diminished if the air is extremely pure, but it is well not to count too much on it in the above-named operations.

For operations in which the traumatic surface can be washed, drenched with a great deal of water, the spray during the operation is less important. Thus, surgeons who employ washes as largely as Volkmann, who pours the strong carbolic solution upon the wounds from a watering-pot, may in certain cases neglect it; but it is always necessary to have recourse to it in the dressings. Lister prefers not to wash and handle wounds under a current of strong water, and therefore holds tenaciously to the spray.

The weak carbolized water (one to forty) is sufficient for the spray; but it is to be remembered that this is true only when the hand-apparatus is used. With the steam apparatus, which dilutes the jet of spray with water from the boiler, somewhat stronger solutions should be employed (one to thirty or forty).

It is very important to use only very pure carbolic acid for the spray, that neither patient nor surgeon may be incommoded. There is a great deal of difference between the carbolic acids; in England and Germany the spray is not at all disagreeable, as the products employed are pure. If the purity of the acid permits the omission of alcohol from the solution, the spray is much less offensive to breathe.

An assistant takes one of the numerous spray-producers, and stands with it at a distance, which is determined by its

power of projection, in such a manner that the wound is always at the point where the cloud is the largest and the spray the finest. It is the duty of the assistant to look out for the continuousness of the stream, to prevent it from deviating, and to keep it from inconveniencing the operator and the patient. If there is any interruption of the stream, he must cover the operating field with a compress saturated with a one-to-forty solution until the jet can be renewed.

All spray-producers are constructed upon substantially the same principles. A powerful stream of air or steam is driven through a tube, whose orifice of exit is very small and placed just over the mouth of a similar tube, the lower end of which is immersed in the liquid which is to be reduced to a spray. The rapid current of air or steam produces such a reduction of pressure in the second tube that the liquid rises in it; and as soon as it emerges from the upper end, the impact of the air or steam breaks it into a spray of such fineness that the process is sometimes extravagantly called atomization. In an apparatus which is driven by a bellows, the weak carbolic solution may be used; but in one worked by steam power, the strong solution is necessary, because the steam dilutes the liquid and consequently weakens it.

The simplest of the spray-producers is that of Richardson, the bellows of which is worked by the hand. The weak carbolic solution is employed in using it.

There are some decided objections to this apparatus; the spray wets and chills the patient too much, almost freezes the surgeon's hands, and is of too small volume; the assistant who works it soon becomes fatigued; and, if it gets clogged, grave inconvenience results. One of these objections may be avoided by using a recently constructed improvement of Collin, in which a little movable rod is placed inside the suction tube, and so arranged that by pushing it upwards, any

obstruction to the flow of liquid through the aperture of exit is instantly removed.

It is very inconvenient to use several of these machines at once, and so I have had Collin make me a spray-producer on the same principle, with three beaks instead of one. The volume of spray from this triple apparatus is sufficient for a large operation, especially if the beaks are made to diverge. If one of the tubes should chance to become obstructed, the spray will still be abundant, and no trouble ensues. The bellows is very large and is worked by the foot without fatigue. Unfortunately this apparatus wets the parts a good deal, and chills them after a time, even when hot liquids are used.

The bellows apparatuses may properly be used in small operations and in dressings, and they have the advantage of those driven by steam in requiring no expenditure of time in preparation and no consumption of alcohol. The fineness of the tubes sometimes occasions inconvenience, as the least dirt chokes them. The end of the suction tube which is immersed in the fluid should be furnished with a little linen filter, and a similar device should be employed at the free extremity of the bellows, to prevent the particles of all sorts, which are always floating in the air, from being drawn into the tube.

For all major operations the steam apparatus is indispensable. It keeps at work a long time without attention, and the spray which it furnishes is perfectly continuous and finer than that from the air machines.

Lister's steam spray-producer is, in all respects, an excellent instrument, and its perfection is an abundant excuse for the complexity of its structure. It consists of a boiler with a safety-valve, the escape-tube of which is provided with a spout through which the stream of steam is projected. The lower tube meets this at an acute, instead of a right, angle,—

an arrangement upon which Lister lays great stress. The boiler is heated by a spirit-lamp, the circular wick of which heats a tube at the extremity of which burn the vapors of alcohol which are set free. There is an arrangement by means of which the flame can be increased or diminished, according as more or less steam is needed. In the English hospitals the lamp is often surrounded by a wire gauze. A vessel for the carbolized water is fastened in front of the lamp. This apparatus is inconveniently heavy and very costly; but it gives so very fine a spray that the operator is not wetted at all, and it runs, according to the volume of spray, two hours or more, that is, all the time necessary for a capital operation.

M. Collin, our ingenious instrument-maker, has made me an apparatus which, it seems to me, could be improved only by borrowing all the constituent parts of Lister's spray-producer. It presents some modifications, some perfection of detail, and, best of all, is so much less expensive that the most impecunious hospital can afford to buy it.

It differs materially in form from Lister's. The boiler is spherical, that shape being chosen on account of the ease of heating and the greater strength. Like all the steam apparatuses it has a boiler, which is heated by an alcohol-lamp. At the upper part of the boiler are a sort of funnel which gives an opportunity to see when the boiler is full, and thus makes the employment of a movable funnel unnecessary; a safety-valve; two tubes for the exit of steam, which can be moved up and down so as to permit a variation in the direction of the stream. These tubes have no stop-cocks, but, by a very simple mechanism, close when they are lifted well up. Each meets at an acute angle the tube by which it draws up the carbolized water which is placed in the reservoir in front. At the lower end of each of the immersed

tubes is a little sponge, which filters the liquid which passes into them.

The spray is very fine, does not wet, as that furnished by most machines does, and covers a large area. The arrangement which gives two beaks instead of one I have long considered very important, not because there is need of two simultaneous streams, but because we want to be able, whenever one of the beaks becomes clogged in the course of the operation, to open the other immediately without moving the apparatus. Several manufacturers in England and elsewhere have since adopted the same arrangement.

If the apparatus is started with a full boiler, it will go more than two hours uninterruptedly. It runs with a low pressure, but is tested at a very high one in order to avoid the danger of explosion. It is quite large enough, and yet is not very heavy.

The wick of the lamp is sheathed in two metallic tubes, so arranged that the flame can be increased or diminished at pleasure. Thus, when the escape-tubes are closed, a very little heat can be furnished, just enough to maintain the pressure. The lamp is filled from the side.

At the beginning of the daily visit, we fill the boiler with hot water, supply the reservoir with strong carbolic solution, screw on the stopper, and light the lamp. We carefully watch, and lower the beak when pressure is got up, or allow even more pressure than is absolutely necessary, lest it fall too rapidly and the stream be imperfect.

If we expect to use the machine for a long time, and the pressure is very high, we may well lower the wick, and, after a few minutes, raise it again.

Generally the stream of steam has a characteristic blue color when it pulverizes well; and, by pinching the rubber suction-tube, its thorough performance can be assured.



Fig. 1. — LUCAS-CHAMPIONNIÈRE'S SPRAY-PRODUCER.

Great pains should be taken to keep the reservoir well supplied with carbolic solution.

If there arise any indications of failure of the steam, the lamp should be instantly extinguished to avoid burning the boiler. However, by lifting it, after a little experience one can tell by its weight when the boiler is nearly empty, and then it should be replenished at once. For this purpose, the lamp being extinguished, the steam is let off by the valve and both the tubes, and then one can unscrew the stopper without danger of burning himself. In replenishing the boiler, only hot water should be used; in this way we avoid ruining the boiler, pressure is got up much more quickly, and the consumption of alcohol is diminished.

When we have finished using the apparatus, it is well to completely empty the boiler, that we may know exactly the quantity of water to put in the next time.

The boiler of my spray-producer holds about a liter, the lamp about half a liter.

If the apparatus is needed for a short dressing only, it is sufficient to half or even quarter fill the boiler: the less water there is, the sooner will the steam be generated.

Some surgeons have thought it necessary to fill the atmosphere of their amphitheatres with a thick cloud, others have set up costly high-pressure machines; but I think my spray-producer suffices for all wants. It is placed upon a table at the distance of two meters from the field of operation, which it envelops in a cloud which neither obscures vision nor wets. Being constructed on the principles so ably expounded by Lister, it cannot fail to give satisfaction.

Finally, it is worth while, in the interest of economy, to bear in mind that such a spray-producer is not only valuable for the special service it was designed to perform, but is of great use in making a spray for inhalation and in purifying and disinfecting the wards.

Among the spray-producers of American manufacture one



Fig. 2.

of the most reliable is that represented in the accompanying cut. It has a spherical boiler which is tested by a hydrostatic pressure of more than one hundred pounds to the square inch. The tubes are of brass, with platinum nozzles, and can be readily removed and replaced, so that tubes for other than antiseptic purposes

may be substituted. In the lower tube there is a clearer which is easily operated. The lamp-jacket confines the heat under the boiler and protects the flame from currents of air, but does not prevent a view of the flame. The lamp is provided with a flame-regulator and an extinguisher, which can be operated from the outside, and it can be replenished with alcohol safely while in operation. This apparatus is advertised to run between three and four hours with one filling of the boiler. It costs twenty-five dollars.



Fig. 3.

A much cheaper, but quite efficient spray-producer is shown in Fig. 3. The essential points are substantially like those in the machine just described. The price of this is twelve dollars.



Fig. 4.

Dr. Weir's apparatus, pictured in Fig. 4, is a modification of Lister's, constructed to avoid the great cost of the latter, without sacrificing any necessary details. It is furnished for fifteen dollars.



Fig. 5.

but is allowed to flow down from the elevated tank, the force of the stream being regulated by a stop-cock.

Another ingenious and inexpensive instrument is that devised by Dr. Hanks, and shown in Fig. 5. The spray can be projected at any angle. The antiseptic fluid is not drawn up by the force of the steam,

CHAPTER X.

CATGUT.—ITS USES AS A LIGATURE, FOR DRAINAGE, AS A SUTURE, AND IN THE PLUGGING OF BONY CAVITIES.

ONE of the most remarkable points in the practice of Lister is the employment of carbolyzed catgut. This is certainly one of the important triumphs of surgery.

As has been remarked previously, a foreign body in the tissues induces suppuration, if it is charged with germs; but if it is aseptic, it may remain an indefinite time without exciting the formation of pus.

At the outset, struck with the disadvantages of ligatures which needed to be discharged and which excited suppuration in the depths of wounds, Lister made experiments to determine the effects of ligatures impregnated with fermenticide substances, particularly of hemp or silk soaked in a concentrated solution of carbolic acid.

Although the first results were favorable, Lister thought that, if he could find a substance which would unite with the tissues or even be absorbed into them, the result would be incomparably better. The idea then occurred to him to employ catgut which had undergone fermenticide preparation, and, after a number of trials, he achieved success. This ligature has properties so valuable that it is necessary to detail the mode of preparation.

Catgut is made, as is well known, from the intestines of the sheep. We select cords of various sizes as they are found in the market, and it is well to know that they should not be very old and dry, and that those made in some countries are

superior to those made in others. The most solid and resistant are made in France.

In the condition in which we find it, the cord cannot stand the tying of a knot; it will often break. Thus the preparation which it receives gives it strength, and at the same time deprives it of germs.

It is steeped for from four to six months in the following mixture:—

Crystals of carbolic acid are dissolved in one tenth part their weight of water, and five parts of olive-oil are added, and the whole is intimately mixed. The cords are placed in this emulsion, where they first swell, soften, and become opaque. After some time the thread becomes firmer, transparent, and more solid. The knot made now is very strong, does not break like one in a cord which has not been prepared, and does not slip as it does when oil only has been used in the preparation.

It is a very curious fact that if, instead of adding water to the carbolic acid, we dissolve it directly in the oil, the effect upon catgut soaked in it is totally different, for it becomes soft and slippery as soon as it is wet, and is of no use whatever.¹

Although a good deal of time is consumed in the process

¹ Lister devoted his inaugural address as president of the Clinical Society of London, on the 28th of January, 1881, to the subject of the catgut ligature, and gave the results of his experiments to find a method of preparation which should obviate the necessity of consuming so much time as the above plan requires, and still produce a trustworthy article. He recommends the following process:—

Dissolve 1 part of chromic acid in 4,000 parts of distilled water, and add to the solution 200 parts of pure carbolic acid. Into this liquid immediately put catgut equal in weight to the carbolic acid. At the end of forty-eight hours, the gut is sufficiently prepared. Then it is removed from the solution, dried, and placed in one-to-five carbolic oil. It is then fit for use.

of preparation, we get in return a thread which remains good indefinitely, if it is kept immersed, and even may be said to improve. Thread thus prepared is in every respect fit to be left in the midst of the tissues. This substance possesses, in fact, the property both of remaining without injury, and of disappearing little by little. It seems that it identifies itself with the tissues, or is absorbed. Experiments upon animals have shown that, after a certain time, only the knot can be perceived and distinguished from the artery and the peripheral parts where the ligature was left. We thus see that this ligature, instead of provoking the process of elimination, the result of which is the decay of the thread, in no way irritates the parts where it is found. Instead of cutting, it supports them; it sustains them at the first moment of the ligation, and will continue to do so for a long time. This result is obtained when the ligature has been placed at the extremity of a severed artery, as in a stump, and also when it has been put around an artery in its continuity.

In a stump the ligature, being cut short, remains, and does not prevent union by first intention. Even if it has been put upon tissues particularly susceptible to external irritation, it is proved that they do not resent its presence. Lister has had occasion to close wounded veins with catgut sutures, and the stitches have not been thrown off.

Keith, of Edinburgh, so well known as one of the most successful ovariologists, told me that he constantly and freely used catgut ligatures in the peritoneal cavity, that he had thus left a considerable number of them at a time, and that no accident had ever happened in consequence, even before he employed the antiseptic method. Many others have followed his example, and I among them.

I have already had a large experience with catgut, having employed it particularly as a ligature in every way, and it

has never failed to fulfil the promise of the theory ; and I insist upon this fact, — that one derives from it many other effects than that of a simple ligature in a wound.

It strangles the tissues sufficiently to arrest bleeding and yet does not kill them, if the wound is kept aseptic. If it is poisoned, casting off of the ligature is common.

For example, when one practises castration, he can ligate the cord *en masse*, close the wound with sutures, and the end of the cord will not be thrown off. In 1876 I operated at the Hôpital Necker for the removal of a very large sarcoma of the testicle, and in seventeen days the patient was completely cured without the discharge of the ligature.

In the operation for strangulated hernia I have a number of times tied the omentum in little parts, and then reduced it or left it in the wound. The portions of omentum which were thus constricted were not eliminated, and the rapid union of the lips of the wound was not interfered with. (An excellent method for omental hernia, founded upon this principle, has been published by Dr. Chiene.)

This is the principle which has been applied by ovariologists, who divide the pedicle into several parts, tie each with catgut, and drop it back into the abdomen. Some close the abdomen with the complete suture, others drain it, as in all operations by the Lister method.

It is evident that the soft parts may be constricted by catgut ligature without mortifying. One reservation must be made,—the parts compressed must neither be too voluminous nor have been previously mortified.

In one hernia operation I saw one ligature out of seven thrown off with a little tuft of omentum, and the final healing was retarded some days. But here the last part of the dressing was not aseptic; and when the dressing is rigorously aseptic, this occurrence is not at all likely to take place.

Catgut must necessarily be employed for the sutures, for it renders valuable service when used in certain conditions. But there is room for discussion as to these cases, on account of the lack of solidity and also the swelling of the thread.

We know that the substance which forms catgut is rapidly absorbed in the tissues. Numerous experiments have been made on this point, and we now consider as utterly incorrect the view that there takes place a veritable organization of the animal cord, which begins by swelling and appropriating young elements, and then disappears from the midst of the tissues, leaving new vessels in the place which it occupied.

Whatever may be the method of this disappearance, it is actually effected, and Chiene has derived from it his method of drainage so eminently favorable to the rapid union of wounds.

Another application of catgut is in the arrest of hemorrhage at the bottom of osseous cavities which bleed freely. Lister has reported among others the following case: in trephining a skull in the median line he opened the superior longitudinal sinus. He crowded pieces of catgut into the hole made by the trephine until it was completely full, and the blood was stayed. The catgut disappeared gradually, and the patient recovered without accident.

In the same manner we insert in the osseous canal after amputation a bunch of catgut to stop the bleeding, which being accomplished, the catgut is left in place, and no harm follows.

In each of the special chapters the uses of catgut are mentioned. It should be known that it may be employed like other threads; when it is well prepared it is simple and easy to manage. I am in the habit of employing thread of quite large size, considering it useless to take the fine, as thread of

any size disappears. I make three knots instead of two, to guard against the possible slipping of the second.

I have described the manufacture of catgut with some minuteness, because the commercial article is often a mediocre product, made hastily, with cord of poor quality, without the addition of water to the oil, or without a lapse of time sufficient for its preparation. To this I attribute most of the objections falsely made to the employment of this very valuable material.

CHAPTER XI.

INFLUENCE OF THE METHOD UPON THE PHENOMENA OF REPAIR. —
THE ABSENCE OF SUPPURATION. — THE BEGINNINGS OF EXPERI-
MENTATION. — ABSENCE OF MICRO-ORGANISMS.

WE have considered the principles of the method and the details of the dressing. What are the results?

At first thought it would seem to be easy to decide this question by a reference to statistics. Of these we have already valuable elements, as will be seen in another chapter. But the method is quite new; it has been misapplied and perverted by many who have scant knowledge of it, and yet publish in its name results which are barely improvements on those of other methods; and even the method of the last years is much surer than that of a decade ago, and the figures of the former period are not to be compared with those of recent times. From this it is evident that the data are insufficient, and besides one can easily make whatever he wishes of statistical figures.

But we have more precious elements, of which the first is the unanimous opinion of those who have thoroughly adopted the practice of antiseptic surgery. There is but one voice concerning the general progress of surgery; every one says, —

“The ranks of my patients were formerly decimated by surgical complications, especially by purulent infection. I have seen these complications disappear from my wards. Not only to-day do I no longer fear purulent infection, septicæmia, but I practise as I choose all the operations which are most hazardous to patients, — upon the bones, articulations,

and veins,—and I see no harm result. Hospitalism is a word which has lost its meaning. It gives so little inquietude that one may defy it in his wards.”

These statements, coming from eminent men of large experience, are calculated to excite us, but it would take a long time to convince us of the reality of these marvellous results and of much other progress, if it were not easy at the first trial to comprehend, avouch for, and even explain them by the study of the phenomena of repair. We no longer seek an explanation in the enthusiasm of the inventor or his disciples and in the allurements of novelty.

Careful observation made in our hospitals, as well as in Edinburgh, London, Denmark, Germany, indeed, all over the world, prove to the most incredulous the marvellous change in the phenomena of repair, which is in a way the criterion of the worth of the method.

The phenomena of repair.

From the first essays of the method, the observer is greatly impressed with the totally new progress of the reparative process. Formerly, in all wounds of any importance, the following phenomena were, in varying degrees, observed constantly: change in the appearance of wounds and the surrounding parts, swelling of the edges, suppuration, great tenderness, tension, and pain; at the same time more or less severe traumatic fever.

If the surface of the wound was extensive, suppuration was abundant, and the dressings always exhaled a more or less fetid odor, particularly if the fluids had been retained a little while. If clots of blood had accumulated in the wound, after remaining a time they were detached and formed a magma, which was fetid from the suppuration which at-

tended its removal. Fragments were left behind which seriously interfered with repair and invited complication.

Then the period of inflammation passed away, suppuration diminished, granulations sprang up at all points where union by first intention had not taken place. Cicatrization was obtained only with more or less lengthy suppuration, involving either a part or the whole of the wound, with divers variations during the continuance of the reparative process.

But with the antiseptic dressing nothing is the same. All the parts which are brought together by suture unite. From the depths of the wound drains off abundant serum, blackish at first, but later only turbid or yellowish. This discharge diminishes little by little, and soon becomes insignificant.

Around the wound there is no swelling or redness. On the eighth day a stump presents the aspect and color which were observed on the first.

If clots of blood have been enclosed under the flaps or between the lips of the wound, instead of disintegrating, of provoking suppuration, of hindering union, they take part in the phenomena of repair. Their surface takes on a very characteristic grayish tint. They adhere to the lips of the wound, some effort is necessary to detach them, and, after some days, if they are scratched, the surface bleeds, new vessels having formed in them. According to Professor Lister, they become organized where they lie. Surely, the operator cannot doubt their presence in the wound.

In the dressing there are no infecting fluids, no bad odor. At no time after their application do the pieces of dressing emit any odor but that which is characteristic of the resin and carbolic acid which they contain.

The phenomena of repair in all tissues, especially in those far below the surface, are accomplished with inconceivable rapidity.

I have observed this so many times that I am surprised when this rapidity does not obtain; but I was much struck in seeing at the Edinburgh Infirmary, in 1875, a wound twenty centimeters long, from the ablation of a breast, healed in nineteen days. Furthermore, a woman in whom the external iliac had been ligatured was well in less than three weeks. At the same time, Lister told me of a resection of the knee, with complete cicatrization in fifteen days. Analogous facts are common to-day.

We used to see wounds repair differently, according to the tissues which were involved. Now, whether the wound involves bone, serous membranes, vessels, or areolar tissue, repair occurs with remarkable uniformity.

In all these wounds we leave great numbers of ligatures, which do not become detached, but become incorporated with the tissues, and support instead of destroying them.

Traumatic fever is generally of slight importance, being reduced to its minimum; but it usually is present, though appreciable only with the thermometer. There is very little reaction.

All this has an important bearing on the theory of traumatic fever. I have expressed the view that nothing supports the idea that traumatic fever has a septicæmic origin. It results from a local irritation, reacting more or less upon the economy through the nervous system. Putrid liquids accumulate on the surface of a wound and irritate it; remove them and irritation diminishes, the fever subsides. It does not disappear completely, because there remain some parts which are irritated by the air, the dressings, and the dead elements which are thrown off.

If it were true that traumatic fever depended upon poisoning by putrid materials, it would not exist when the wound was absolutely aseptic. I have elsewhere presented this ar-

gument, and many others, which seem to me equally convincing against the septicæmic origin of traumatic fever. I was very happy to find my opinion in conformity with that of Professor Lister.

I have already pointed out a remarkable resemblance between the thermic results of the dressing of Lister and those of the wadded dressing of Alphonse Guérin, which also diminishes the intensity of the traumatic fever, and said: "Reduce to their minimum the phenomena of elimination, mortification, and local irritation, and you will diminish to its minimum traumatic fever."

That which is, indeed, the most characteristic point in the method of Lister is *the reduction to a minimum of the phenomena of elimination*.

Not only the united lips of a wound are consolidated, but the walls of a traumatic cavity come together and unite under very slight pressure; and suppuration, which is always present when the cavities of wounds heal by granulation, does not take place. Even an abscess cavity does not suppurate.

The liquid which drains from the wounds is so different from common, laudable pus that the two should not be confounded. That which shows this method of repair to be the most perfect is the absence of waste of young cells, which, in wounds treated by ordinary methods, are thrown off in great numbers.

The wound under the antiseptic dressing, says Lister, gives no pus. At first it discharges a sanguinolent liquid, then a darkish serum, then serum which is either transparent or cloudy. There are in it granular corpuscles, but not the masses of well-formed globules which characterize ordinary pus. In this fluid the globules are infrequent, modified, with no definite characteristics.

However, to the naked eye, the appearance of the liquid is

not always the same: sometimes it is viscid, and resembles synovia; at other times it is yellowish, and looks a little more like pus, and may fill up the drainage tubes.

If the wound is irritated and badly drained, the liquid, always scanty, is even more like laudable pus, without its creamy consistency. If the cause of the irritation is removed in the course of the day, the cloudy serum reappears. This is seen in a recess of a badly protected wound, about a stitch which is too tight, in a cavity with too narrow an opening of exit. It should be watched for and remedied immediately.

But if, in the absence of these causes, you see on the surface of a wound a layer of true pus, creamy and abundant, you may be sure that germs have penetrated and the dressing is infected. The patient is not necessarily injured seriously, but he is endangered, and he will recover by the process of suppurative reparation, the ideal of ancient surgery. You may be sure, then, that true antiseptic surgery has not been accomplished.

The more nearly the phenomena of repair approach the type we have indicated, the simpler is reunion; and it is in these cases that we see clots at the bottom of a wound not disintegrating, but taking a gray tint, contracting a little, and becoming penetrated with vessels. If they themselves do not, properly speaking, organize, they contribute to repair; they serve as a woof for the weaving in of the neighboring vessels, which put out buds, and soon their substance is vascular. Their presence assists repair. Lister counts so much upon this phenomenon that, when he scoops out great cavities in bone which cannot collapse, he scrapes the fleshy granulations in the vicinity in order to fill up the osseous cavity with clots; because, when he does so, living tissues occupy it much more quickly, and healing is greatly accelerated.

The absence of the phenomena of irritation during repair

permits each element to live in the midst of a wound as well as, perhaps better than, in the depths of tissues which have not been uncovered. This is what explains how repair is so rapid, so exempt from complications, in the case of serous membranes and viscera, which are prone to inflame. One operates in conditions more favorable, certainly, than those of subcutaneous surgery.

It is so true that inflammation does not occur, that the few operations where it is needed are, in a measure, incompatible with antiseptic surgery. In the operations for pseudarthrosis, the resections produce almost no formation of callus, and the antiseptic method must be abandoned after a few days in order to obtain irritation enough to provoke the required exudation.

Repair is singularly regular. With the old surgery it could be said that each new wound had its own physiognomy; that wounds differed absolutely in appearance and progress, according to the tissues involved. Here, all are alike: the same pallor of the tissues, the same constant union, the same non-purulent discharges, with some differences as regards the amount of liquid and the greater or less duration of drainage, according to the size of the traumatic surfaces. But all points in the wound have the same aspect. The uncovered parts have a certain grayish tint, which is not particularly pleasing to the eye; and they preserve this hue until healing is completed, if they are not molested with untimely friction.

One of the most fortunate phenomena is the freedom from suffering. Partly on account of the anæsthetic action of the carbolic acid, much more because of the absence of irritation, the spontaneous pain is slight, and contact with the wound is not distressing. The patients do not complain at having stumps and immense traumatic surfaces dressed. If there is

pain before the operation, the sedation is marvellous; and we may say that one of the most striking characteristics of services in which the antiseptic method is employed is the appearance of the patients, who, free from fever and pain, eat and sleep and recuperate their powers in perfect quietude.

Local complications are absent. There is repair without pus, without fetor, with reduced fever, without pain, without exhaustion of the wounded. There are no general complications, as we shall see in the following chapter. The most fortunate surgeons used to consider erysipelas and septicæmia possible: certain operations predisposed to these diseases to such an extent that they were specially feared. But now, whatever the man, the medium, or the operation, complications have disappeared; for even erysipelas, which sometimes shows itself, is shorn of its grave character.

Just as the wounds present a very remarkable appearance, the scars also are extremely interesting. They are neat, regular, and linear. Stumps which have not suppurated are supple. There are no cicatricial adhesions, retractions, or indurations. In regions which are accessible to inspection, operations leave scarcely a trace.

What I observed in Professor Lister's service I have seen in my own; and I have been deeply impressed with the fact that I obtained the same results immediately. I was certainly far behind the perfection of the master; and yet, from the beginning, I found the same modification of the processes of repair. I think it very important to put this fact on record, and for this reason I revive to-day the history of the first operations which I made, in 1875 and 1876, in the temporary hospital, with a strict method. These operations were varied, and in all I obtained union, in all the surgical fever was slight, in none was there a discharge of true pus. I may be allowed to cite the amputation of a leg at the upper third,

absolutely cicatrized, epidermis included, in twenty-four days. There was a large clot in the stump, and yet repair was not impeded.

An enormous myxoma of the parotid, larger than a turkey's egg, in a man of twenty-eight years of age. On the fifteenth day there was a little epidermic ulceration. On the eighteenth day I showed him to the Surgical Society, absolutely healed. There never was a drop of pus or puriform liquid in the wound, only turbid serum. His temperature did not exceed 38° C.

A lipoma under the scalp was removed from a man of fifty years. It had the dimensions of a hen's egg, and lay in the left fronto-parietal region. A great deal of blood was discharged into the cavity after the suture was made; but in spite of this, there was no suppuration, and cicatrization was complete in nine days.

Trephining of the greater trochanter, attacked with osteitis in a man of forty-eight, who presented immense fistulæ, commencing at the iliac crest and descending beneath the trochanter. The fistulæ were cleansed and injected with chloride of zinc; the very extensive wound of the operation was closed first, and all the great fistulæ were closed in a month. The dressing was then omitted, and the patient, who had been confined to his bed for eight months, with suffering so intense as to make walking impossible, stepped off without difficulty. I made him go to bed again, because I found that one of the numerous fistulæ low down had been neglected. It was superficial, but pretty long and well-organized, for I made carbolic injections without success. I decided, after some days, to cleanse this fistula by the proceeding previously described, to make a counter-opening, and put in a drain. In a few days it was perfectly closed, and the patient was cured, a result which I verified eight months afterwards.

This man had a long and interesting history. He suffered continually without respite up to the day of operation. I found nothing in the joint to explain this pain and his inability to walk. The greater trochanter was a little increased in size and tender on pressure. A multitude of constantly suppurating fistulæ had followed as many abscesses, but the bone could be reached at only one point. To-day all the fistulæ are closed, and walking occasions no pain.

In this case I made a free incision, and removed a large prominence of the trochanter, the tissue being soft but not carious. Excepting the point where two large drains passed, the whole wound united. Two very firm sutures provoked around them the formation of four or five drops of pus, which I evacuated. The great wound never gave any discharge but serum, at first dirty, then yellowish, and a little viscid after some days. The traumatic fever was insignificant, the temperature never reaching 38° C., and in a month everything was cicatrized. This large wound, complicated with traumatism of bone, behaved like the wound made in the removal of the parotid tumor, which I have just reported.

Besides the major operations made in the first six months of my experience, I reported a number of others of minor importance, not only in the way of congratulating myself on having seen them escape so-called hospital complications, but also to note that the same mode of repair is shown in small as in large operations.

Two amputations in the same patient, one of the great toe, the other of the second, rapidly and perfectly healed, in spite of a diseased and injured skin, and the fact that the ligatures were left in the wound.

I have practised upon two patients denudation of veins for varix, after the manner of Rigaud, which consists in exposing

a large venous trunk and isolating it upon a foreign body, and I was able to note from the very first entire absence of reaction. But I was especially struck at seeing that these isolated veins, lifted up on sounds, did not die under the dressing. The first, which was slender, was well denuded, and placed upon a rubber tube. I supposed, at the first dressing, that the tube would not sufficiently hold the vein, and therefore substituted for it a gum sound. The vein did not break; a little blood was effused around it. At the end of a fortnight, tired out, I removed the sound. The wound cicatrized rapidly, and when the patient, cured of his ulcer, got up, I saw with regret that the vein was perfectly pervious.

In the second patient, finding a large, thickened vein, and foreseeing the same inconvenience, I denuded it extensively and raised it up on two sounds. It died no more than the other. The effusion filled up the wound around the vein, which I liberated at the expiration of twelve days. Nevertheless, the vein was obliterated. The patient, rapidly cured of his ulcer, walked off, provided with a cloth stocking and feeling very comfortable.

In these two cases it seemed that the dressing, which allowed the tissues to retain their maximum of vitality, prevented mortification of the walls of the veins. Therefore, recognizing this absence of reaction, this ease of operation upon the veins, I have devised another operative procedure, for I never had more than moderate confidence in the harmlessness of the original procedure without the Lister spray. Rigaud, having thrice opened veins, lost three patients by purulent infection.

My operation is vastly more simple, much more rapid in its healing, and sure to effect obliteration. It consists in tying the great venous trunks with catgut, which is left in the

wound. I have as yet performed this but once, but it seems destined to give the best results. It is much easier than Rigaud's and is surely infinitely less dangerous.

I have made yet other operations with excellent results.—enucleation of the eye, which I dressed with boracic acid ; extirpation of a neuroma in the stump of a fore-arm.

In another class of cases I have had capital proof of the influence of the method, as illustrated in the opening of an abscess of the neck, under the sterno-mastoid, following angina. The patient, who was in a dangerous condition, being chloroformed, I opened the abscess with antiseptic precautions, and injected the cavity with weak carbolic solution, afterwards using the strong. In eight days, a great purulent sac which had been freely opened was completely closed, and after the primary evacuation there was scarcely any discharge of pus.

In the first edition of this book I reported the preceding cases, and I repeat the record now in order to show exactly what every surgeon can accomplish in his first attempt by strict observance of the method. And yet my conditions were unfavorable, my assistants were inexperienced, I was obliged to disturb myself with pharmaceutical details ; but I contributed an element of appreciation which was of value. The service of the temporary hospital in which I had this experience contained forty-five beds in an old building badly located, of the healthfulness of which I never had a good opinion. During these six months there were six cases of erysipelas, but not one occurred in a patient who had the antiseptic dressing. Three of them were brought in ; three broke out in the wards,—one in a patient who had a little wound of the head without any dressing, the two others in men who had ulcers of the leg. One of these had a severe erysipelas which started up in an almost cicatrized wound ;

the other, with an immense ulcer of the leg, had erysipelas in the face, and died.

Thus it will be seen that the surroundings were far from favorable for operations upon the veins or the scalp.

In the four years which have slipped away since then I have had a large experience. I have made my operations in one after another of the Paris hospitals, some of which are not of the best. I did a large amount of work in the Lariboisière, and also in the Necker. I have operated, or had charge of the operations for the most part, in the following hospitals: Pitié, Hôtel-Dieu, Beaujon, Maison de Santé, Enfants Malades, Sainte-Eugénie, Bicêtre, Saltpetrière, Maternité. Everywhere the results have been the same. Some of the surgeons have continued to employ the method, more or less rigorously — Professors Guyon, Verneuil, Panas, MM. de Saint-Germain, Le Dentu, Terrier, Perrier, and many others. Even those who have not been, in my opinion, sufficiently rigorous, have made such progress that their surgery has changed its appearance. Those who have been more strict have had results identical with my own.

In spite of the importance of this practice, I present no statistics, for I consider mine insufficient. All that I can say is that, when the method has been rigorously pursued, *I have not had a single case of wound complication*, either in an operation patient or in one who has been seriously injured. I have seen neither erysipelas nor purulent infection, and I have dared to do operations which no one before has ventured in France; and when I have applied the method to some wounded men and not to others, it has been used in the most serious of the cases.

I may remark here that, in describing the indications for the principal operations, I shall report cases from my own practice.

I must not close this chapter without saying a word on a most important question. In the midst of the laborious pursuit of antiseptic surgery, I have had little leisure for studying the capital theoretic question, of noticing the presence or absence of living beings in protected wounds. Having no confidence in my personal competence in this respect, I will not report my investigations. I have made a few investigations in ordinary conditions, with negative results; but this small number of observations is not a sufficient foundation for an opinion.

Lister, a singularly competent and strict observer, found none of the organisms of putrefaction in the fluids of his own dressings. His pupils also have searched for the micro-organisms which characterize putrefaction, and have not succeeded in finding them. I am aware that some other authors, particularly Ranke, are said to have found them in the best-made dressings; but even in these cases, the micro-organisms did not resemble those of common wounds, either in form, number, or activity.

On the whole we may assert, upon the authority of competent observers, that microbes are absent in wounds treated in this manner. There is still need of careful observations to rigorously and absolutely demonstrate their absence; but their presence has been affirmed, rather than demonstrated, by the other investigators, who have found them to be infrequent and peculiar.

Are we to believe, with those who have found micro-organisms under the dressing, that their conditions of existence are so profoundly modified that they have become innocent and incapable of doing harm? This idea is defensible. The history of these creatures is not yet written; their varieties may be infinite, and we scarcely know those conditions of their existence which are the most simple and the

easiest to observe. Investigators of high competence must decide at last as to the theory and microscopic observations.

One is apt to think that it is sufficient to take a look in order to judge ; but it is necessary to know how to look, and this is a very difficult matter.

CHAPTER XII.

GENERAL RESULTS OF THE DRESSINGS. — WOUND COMPLICATIONS. — SOME FIGURES. — LISTER. — SAXTORPH. — VOLKMANN.

THE attentive reader of the preceding chapter should be able to foresee the immediate and remote consequences of the application of the method. If it is true that almost the entire traumatic surface is immediately closed, that healing is most rapid, that the phenomena of elimination are reduced to a minimum, that the phenomena of putrefaction are suppressed, it is extremely probable that the accidents of wounds will be infinitely rare. This, in fact, is what all affirm who have tried the method in a serious way. The modification is most striking in the case of purulent infection, pyæmia. We see it disappear at once from certain services where it had been constantly observed; and this was, according to Lister, the first benefit of the application of the method in Glasgow. Hospital gangrene also disappeared, as has been remarked in a number of institutions where it was previously endemic.

Quite naturally, prolonged suppurations and putrid infection are suppressed. Erysipelas is perhaps less influenced, for it is sometimes observed in spite of the dressing; but, nevertheless, it is infinitely less frequent than with other methods, and, as authors say, it is less alarming in its manifestations, even in times when it is epidemic.

These results are not obtained merely by a few advocates of the method, which has made, in spite of active opposition, many more converts than can be enumerated. It has given the same results in every place where it has been adopted.

And, in this connection, it is only fair to note that the published statistics in many countries and hospitals of the more or less fortunate modifications which have been made are far from giving an idea of the success which is attained by the rigorous method.

The complete transformation of surgery is evident. Doubtless there are many who deny the light; but none who carefully study the published facts or well-conducted services can long resist.

Is it necessary, in order to judge of these results, to gather into a common statistical table all the facts which have been reported, and add them up? That would give the most erroneous idea possible. The method is too new to be tested in that manner.

Unlike figures should not be reckoned together; and if, nevertheless, I do so in this chapter, it is for the purpose of showing how the same surgeon, in the same service and at the same period, has abruptly modified his surgery.

The first and most striking example is that taken from the practice of Lister. He inaugurated antiseptic surgery in Glasgow in a hospital situated in the midst of emanations from a graveyard so crammed with bodies that they were hardly covered with earth. The windows of the wards for the wounded were most directly exposed to these effluvia. No change was made in the situation of this hospital, which was notorious for its surgical complications.

Lister compares his results before the antiseptic period with those obtained during it. The method was in its infancy, its success was far from being complete; and yet one can easily see the first transformations which were wrought in the midst of circumstances which, as he has vividly shown, comprised all the special causes of unhealthfulness.

Being unable to find the records of three consecutive years

preceding the antiseptic period, he takes only two years. The antiseptic period includes 1867, 1868, and 1869.

In the first period there were thirty-five large amputations, with sixteen deaths; in the second, forty amputations, with only six deaths. Thus the mortality for amputations was reduced from forty-five to fifteen per cent.

The result was curious, especially in view of the fact that the mortality after the least of these large operations was always due to the dominant influence of hospitalism. Thus, in the first period there were twelve amputations of the upper extremity, with six deaths; in the second, twelve amputations of the upper extremity, with only one death, and this was in the case of a boy who was operated on in spite of the manifest existence of purulent infection.

But this was only in the beginning of his method, and the progress has been immense since then. In Edinburgh he had only one case of purulent infection in six years, this following ablation of the breast; he had in the same period not a case of hospital gangrene. As regards erysipelas, it was very rare, was less severe, and often was situated far from the wound. He had in his wards only two cases of tetanus, and both of these were in patients who had putrefying wounds.

In the least healthy wards, Lister for four years suspended the annual washing which had been customary up to that time. He brought in extra beds; there were sometimes as many as three or four children in a bed. He often had seventy patients for fifty-five beds. The cleanliness of the patients was only relative. Aside from antiseptic neatness, they were dirty enough. Think of dressings remaining in place six or eight days. "From the æsthetic point of view they were foul, from the surgical they were clean."

After his removal to London, Professor Lister continued to

observe the same very happy results. He reserves all these facts for a general statistical table, when they have become very numerous ; but it is proper to state that the success of his practice has in no respect diminished.

Again, we find the same results in the practice of Saxtorph, of Copenhagen, one of the first in Europe to employ the Lister method in a great hospital service, and an ardent advocate of it.

In a hospital whose insalubrity every now and then became so marked that purulent infection swept off his patients, even after an amputation of a finger, he made in 1876 the following operations, the statistics of which he himself furnished me with :—

Eleven resections of the knee, three deaths.

Nineteen amputations of the thigh, six deaths.

Fifteen resections of the hip, six deaths.

Eight resections of the wrist, two deaths.

Seven resections of the elbow, one death.

Six resections of the shoulder, three deaths.

Ten extractions of foreign bodies from joints, freely laid open, one death.

Twenty-two Syme's amputations of the foot, seven deaths.

Eleven extirpations of the calcaneum, four deaths.

But this was only the commencement, the transition from a state of insalubrity to a condition of health, with all the gropings of a beginner in a method ; and his results are very much nearer perfection to-day.

Saxtorph has not reported all his statistics, the figures of which would be enormous, but he has informed us of the sum total of his results after resections, and especial attention is asked to the teaching of this brief statement.

It is easy to follow the improvement in results, step by step, in exact proportion to the exactness of the application

of the antiseptic method. A mere glance at the figures is enough to show that deaths became very rare.

One hundred cases of resection are recorded — shoulder, elbow, wrist, hip, knee, ankle, — and two thirds are of the hip and knee.

The total mortality is thirty-three, that is, thirty-three per cent.

But although the author early brought the method into Denmark, his cases at first were treated without the Lister dressing or with a very imperfect dressing, and here are the figures which they give: —

Before 1873, fifteen resections with nine deaths — sixty per cent. of mortality.

Then the method began to make its beneficence felt, and the sum total before 1877 was seventy-six resections, with thirty-two deaths — a mortality of forty-two per cent.

After 1876 the method was much more rigorously applied, and since 1877 thirty-four cases, the greater part of which were large resections (fifteen of the hip and twelve of the knee), gave only five deaths — a mortality of but seventeen per cent.

“In short,” says Saxtorph, “I have made great progress. Since 1877 I have constructed a spray-producer which enables me to be more rigorous, more exact; and since then I have made twenty-four large resections of joints, almost all of the knee or elbow, and I have lost only one patient, and that one by tetanus, which gives but a trifle more than four per cent. of deaths, that is to say, about a fourteenth part of the mortality of the first years.”

As regards the patients who recover, the results are incomparably superior, the functions of their limbs being much more surely restored and the absence of complications remarkable.

With such results, one can easily understand that Saxtorph writes me as follows :—

“ There is nobody, I think, in Denmark who does not use the Lister dressing in his operations. As for me, I would give up the practice of surgery, if I could no longer operate antiseptically.”

The most curious of all the personal statistics are those of Volkmann, of Halle, whose surgery passed from the most wretched results of hospitalism which can be imagined to the most perfect security that one has a right to wish for.

He had a deplorable induction, into a hospital manifestly infected. At the time when he began to employ the method, Volkmann, in utter despair of their sanitary state, was on the point of demanding the closure of his wards. It would seem that their aspect was not enchanting if we may believe the description of Dr. Schuppert, of New Orleans, who made very careful observations of the antiseptic method throughout Germany. He says :—

“ It is an old, miserable building, tumbling into ruins, situated in the midst of a dense population, surrounded by narrow, dark, and filthy streets. This hospital, if such it may be called, has no other means of ventilation than that by infrequent and narrow windows.” — *N. O. Medical and Surgical Journal*, March, 1876.

The results were quite in harmony with the appearance of the hospital ; purulent infection and all the complications of wounds raged with a violence previously unheard of, and, to cite only one class of wounds particularly, the author reports that in 1872–73 he attempted to save sixteen cases of compound fracture, and twelve of them rapidly succumbed to pyæmia.

In 1873, Volkmann in despair made a trial of the Lister dressing in all its strictness, and from that time to 1877, he

employed conservative treatment in seventy-five complicated fractures in seventy-three patients, without a case of death. And all his surgery abruptly assumed an aspect of which some idea may be obtained from the brief report which he made to the Congress of German Surgeons, in April, 1877, the essential points of which are subjoined.

Operations performed in the Clinic at Halle from the 1st of March, 1874, to the 1st of March, 1877. Ten thousand cases, of which one thousand were large operations or grave injuries.

AMPUTATIONS AND DISARTICULATIONS.

Simple Cases.

Disarticulation of shoulder, four. One death after four hours.

Amputation of arm, fourteen. No death.

Amputation of fore-arm, twenty-three. No death.

Disarticulation of wrist, three. No death.

Disarticulation of thigh, two. One death after four hours.

Amputation of thigh, forty-two. One death after twenty-four hours.

Amputation of leg, twenty-five. One death from erysipelas.

Partial amputation of foot, forty-two. No death.

Complicated Cases.

Double amputation, nine. Two deaths, both patients having suffered amputation of both thighs.

Serious multiple lesions, six. Six deaths; traumatism with or without operation; death in a few hours.

Operations in the course of septicæmia, fifteen. Eight deaths.

Deaths from intercurrent maladies : —

A man of sixty, whose thigh was amputated, died of delirium tremens.

A tuberculous girl of sixteen died of pneumonia.

A woman of twenty-four had the humerus amputated for phlegmon. Abortion followed, and she died of puerperal fever.

In these cases, cicatrization was almost complete at death.

The total of the large operations was one hundred and seventy-two, with twenty-three deaths—a little more than thirteen per cent.

RESECTIONS.

Uncomplicated Cases.

Shoulder, seven ; elbow, two ; wrist, two. All cured.

Hip, forty-eight. Four deaths, two of them after three months, the others in children aged nine months and two and a half years respectively.

Knee, twenty-one. One death from tuberculous meningitis.

Tibio-tarsal articulation, five. No death.

Complicated Cases.

Four in patients already suffering from septicæmia or pyæmia. Four deaths.

Resections in the continuity of limbs : for false joint, nine ; for vicious callus, one. No death.

Osteotomy ; fifty operations on thirty-eight patients. One death from hemorrhage in a bleeder.

Operations on the breast : one hundred and nineteen on one hundred and ten patients. Six deaths : two of erysipelas, one arising from neglected dressing, the other from an eschar

on the sacrum; one of shock; two of exhaustion; one of malignant pustule, communicated by the catgut.

Incisions of hydroceles, forty-five cases. No accidents.

Complicated fractures treated conservatively, seventy-five in seventy-three patients. No death.

Secondary amputations: thigh, one; knee, four; leg, forty-two; arm, six; elbow, five; fore-arm, fifteen. No death.

During this period of three years, there was not a case of purulent infection excepting such as existed on admission to the hospital.

There were three or four cases of erysipelas in patients treated antiseptically, and some others in the non-antiseptic.

From these statistics it is worth while to select a few which are really remarkable and very important. For example, Volkmann reports resections of the shoulder cured in fifteen days; a resection of the elbow healed without pus in nineteen days; one of the hip on the ninth day without a drop of pus; and one of the knee in a child of nine years, having caries with luxation and a large abscess, uniting without supuration. A month after the operation, the wound being completely healed, the child was walking about without a stick, his limb being supported by a splint. The bone tissue was so soft that it was cut with a knife.

A man of forty-five years, who had suffered disarticulation of the thigh on account of a myxolipoma sixty centimeters in diameter, had his wound completely healed in ten days, excepting the track of the tubes.

A woman, aged eighty-four, recovered from amputation of the thigh, necessitated by an injury.

A patient, from whose back a fibro-sarcoma measuring twenty-five centimeters in diameter was removed, left the hospital on the fourteenth day.

I hardly know where to end my recital of these curious

examples of rapid repair, but I must add the remarkable experience which Dr. Auguste Reverdin reports to me, of a patient both of whose feet were amputated by the Pirogoff method, six weeks intervening between the operations. The first was completely healed in fifteen days, the second in seventeen.

In describing the antiseptic surgery of Volkmann, I should have said that his practice does not differ from that of Lister. He is rather more inclined to employ compression above the dressing. In places where it is difficult to accurately apply the dressing, he often completes it with salicylic wadding.

I may add that Volkmann, to a much greater extent than Lister, employs irrigation with the strong solution, which he pours out from watering-pots lavishly in every direction in his amphitheatre.

At the present time the surgeons who have adopted the method are innumerable; but we must make mention of our colleague, Jules Boeckel, of Strasburg, and Nussbaum, of Munich; and we could give the names of English, German, Danish, Dutch, Austrian, Swiss, Italian, Russian, and French surgeons who have successfully practised Listerism.

I have already said what my results have been with antiseptic surgery in the hospitals of Paris; and yet I desire to repeat that I have made a great many capital operations without encountering a wound-complication. The only patients I have lost were those who could not withstand traumatism, and some of these survived only a few hours.

I could quote Guyon, the member of the Surgical Society who has most rigorously applied the Lister dressing, and whose first attempts gave the following results: twenty-one capital operations, twenty-one recoveries; seven herniotomies, five recoveries.

To show that every one can easily obtain equally good re-

sults, I may be allowed to mention the first experience of my associate, Dr. Gilbrin, surgeon of the hospital at Metz. In 1874 he was in utter despair at the results of his surgery in the hospital, having exhausted almost all known means to prevent the accidents of wounds. He could not operate upon a patient without having hospital gangrene set in. Having read in the *Journal of Practical Medicine and Surgery* a review of the thesis of Zayas Bazan, he procured it, and resolved to devote himself to the strict execution of the prescriptions of antiseptic surgery. He began on the 1st of January, 1875, with this very concise guide. From that day on there were no accidents, not another case of hospital gangrene occurred; and yet he performed operations which, in the former circumstances, he would not have dared to undertake. To-day Gilbrin has perfect results, and is an ardent disciple of Lister.

If we do not yet say, with Socin, of Bâle, that every subject of amputation who dies of purulent infection or erysipelas is a victim of ignorance, lack of skill, or neglect of the surgeon, at least we think this is so near the truth that we look upon it simply as a vivacious expression of his idea of the power which the Lister method has given to surgery.

CHAPTER XIII.

PARTICULAR OPERATIONS AND DRESSINGS. — PRACTICE AND RESULTS.
— IMMEDIATE UNION. — PLASTIC OPERATIONS. — EXTIRPATION OF
TUMORS OF THE SOFT PARTS.

IN describing certain great operations, and the dressings adapted to them, I shall point out the particular conditions of each case and the results obtainable.

Immediate union. Plastic operations.

Many surgeons with good reason say that immediate or rapid union is one of the greatest advantages of the method. Not only is this assured in all plastic operations, where we formerly endeavored to obtain it, but in all operations, whatever may be the nature or the depth of the wound, if its walls can be brought into apposition.

In four years I have seen a failure of union not more than two or three times. The wound always unites, if it is antiseptically clean and its walls are held in contact with sufficient firmness. This healing is surprisingly easy, not failing on account of the presence of small blood-clots, or the imperfect suture of the parts.

The deep suture, which some have considered the principal feature of the method, is really an accessory measure, and, if it is not narrowly watched, it is more likely to hinder than to favor healing, by inducing the formation of purulent sinuses.

It is, on the other hand, of the first importance to provide

for drainage, and this all the more because parts which have been bathed with carbolic acid exude a large amount of serous fluid.

But, these conditions being fulfilled and antiseptic protection assured, union will take place not only after all great surgical operations, but also after those interferences which formerly we hardly dreamed of having it follow, such as the opening of large abscesses and articulations.

I have had union in all regions, even in those where attempts at healing are often vain, such as the integuments of the skull, after removal of wens and lipomata, and after contused wounds; in the face, after operations for the removal of sequestra. I have always obtained it after operations involving the peritoneum, as in strangulated hernia, after evacuating large abscesses, and after opening joints.

It is clear that, to favor this process, it is wise to retrench the tendons and aponeuroses which protude in the depths of the wound, and to so arrange the various parts that apposition shall be perfect. It is almost a matter of indifference what materials are employed to effect coaptation; metal, carbolized silk, and catgut, all in turn have given good results.

In plastic operations drainage may be entirely useless, or may be accomplished with a bit of protective. It is well to cover the united parts with fine linen saturated with boracic ointment, and cover it with boracic dressing. If the flaps are large, it is an excellent plan to wash them with carbolic acid; if they are small, the boracic solution may be sufficient.

Removal of tumors from the soft parts.

All the tumors to which a common treatment is applicable may be described together: superficial and deep lipomata, tumors of the breast, tumors of the parotid, degenerated

ganglions, etc. In all these cases I have tried the antiseptic method, and I will give the general rules, which should be followed.

The incisions, whether single or multiple, should expose the tumors in their entire extent. A long incision is not a disadvantage, as the scar is linear, and it gives an opportunity for radical extirpation, and prompt and certain arrest of hemorrhage.

All tissues which will prevent the healing process, such as fibrous envelops and cyst walls, should be carefully removed. The cavity produced is washed out with strong carbolized water, after bleeding has been stopped. I have often done it with an eight per cent. solution of chloride of zinc, with very good results; but a livelier reaction and greater pain are liable to follow.

If the soft parts which are to be united are very far apart, one, two, or three deep stitches may be taken, compression of the drainage tubes always being scrupulously avoided. On the following days a strict watch should be kept on them, that they may be removed as soon as they have fulfilled their mission.

There is danger that the superficial stitches may be drawn too tightly. Silk or catgut may be used, but I prefer silver, though sometimes employing catgut. The last is especially applicable to wounds of small extent. This thread, which swells by absorption of moisture, must be carefully watched.

Drainage is very important, and, if the cavity is of great size, it is wise to insert several tubes, and remove them as soon as their work is done.

Compression with carbolized sponges placed in the dressing above the protective is here a great assistance. They are of advantage by absorbing the discharge and favoring apposition by the compression which they exert.

I have extirpated a large number of different kinds of tumors. I may mention the ablation of a mass of enlarged lymphatics from the axilla of a little girl of fifteen. The glands extended as high as the clavicle; and yet, after the lips of the wound were sutured, and the dressing carefully applied with sponge compression, complete healing of this immense cavity took place in two weeks. I have got complete and rapid healing after the removal of an enormous lipoma of the nape, and also after ablation of mammary tumors.

In all cases of tumor, it is of the utmost importance to obtain very rapid union, for without it healing is indefinitely delayed; we must not be afraid to bring the lips of the wound together even forcibly, if we watch the sutures and are ready to loosen them at the least sign of inflammation. In these cases, the wound should be dressed daily.

In the treatment of tumors, the salicylic wadding or lint is often useful to make compression upon the remaining cavity.

CHAPTER XIV.

COMPOUND FRACTURES. — PURIFICATION. — IMMOBILIZATION. — GUN-SHOT WOUNDS IN MILITARY SURGERY.

THE antiseptic treatment of compound fractures and gunshot wounds gives marvellous results; but these depend mostly upon the pains bestowed upon the first dressing. As the air has penetrated to a greater or less extent, we should not concern ourselves as particularly with the application of the spray as with the perfect purification of the wound and all its sinuosities. At the time of the subsequent dressings, the wound naturally being supposed to be aseptic, the spray is of the utmost importance.

The wound and the surrounding parts having been thoroughly washed in the one-to-twenty solution, we carefully examine it and find out whether it will be possible to reach with injections to the bottom of its cavities. If these are large, with narrow orifices, we need not hesitate to enlarge the openings sufficiently to insure purification. We do this the more readily because, after the washing is completed, it is easy enough to take a few stitches and close the wound of the bistoury. It is also well to secure the detached flaps with sutures.

The washing of the cavities should be scrupulously made with strong carbolized water, and for this purpose a good rubber bulb charged with the fluid is very convenient.

If the wound-cavity is not uncovered, it is very convenient to introduce a soft tube, and make the injection through it; in this way the distant crevices can be reached and the return

of the fluid assured. This last point is exceedingly important, for we must not forget that there are loosened flaps and denuded bone, and by forcible injections the injuries of the soft parts may be aggravated, and hemorrhage is provoked.

In cases where the fracture dates far enough back to have become poisoned, or where it has been contaminated with impurities at the time of injury, it may perhaps be well to use a twenty-per-cent. alcoholic solution of carbolic acid for the washings and injections. But it should be borne in mind that this solution is powerfully caustic. We should be moderate in the use of it, not slopping it upon the skin, which it will burn, and not forcing it violently into the tissues, lest it excite active inflammation.

The aqueous solution gives the blood a chocolate-brown color; the alcoholic imparts a gray hue to the blood and uncovered muscles which shrivel at its touch, and the burning sensation is intense; whereas, in the first case, the patient has little suffering.

If the fracture is of several days' standing, and suppuration has set in, we must not hesitate to freshen the cavity with the curette and purify it with chloride of zinc. In this case, the greatest circumspection should be observed in the injection, and, as the solution is very caustic, its complete return should be insured. I do not much favor its employment in the beginning for a fresh fracture. It has, indeed, been recommended; but it seems to me to be, at least, useless in such cases.

In compound fractures the care bestowed upon the drainage should be in proportion to the irregularity of the cavity. It should be aided by gentle compression with sponge or gauze. At each dressing, one can make sure that there is no retention of fluid, by making light pressure and thus emptying the *culs-de-sac* and ensuring rapid repair.

It is useless to insert the drains as far as the centre of the fracture. It suffices to place them below and along side of the bones.

We should bear in mind that it is generally of no use to repeat the injections, the dressing having been once well applied, and that, on the contrary, this proceeding disturbs repair, prolongs the cure, and even provokes suppuration.

Ordinarily the dressing is made with quite thick layers of gauze, because its form is necessarily irregular, and because there is often abundant discharge.

Of all solid appliances the plaster bandage is the most easily combined with the antiseptic dressing. If the openings in the apparatus are not very large, it is well to line their edges with antiseptic gauze, under which we slip the impermeable. The dressing must be frequently renewed.

Finally, in the dressing of compound fractures, the salicylic wadding or jute answers a good purpose in filling up empty places and completing the dressing.

In the cases where I have feared that antisepsis was not well assured, on account of the necessary narrowness of the openings of the apparatus, I have enveloped the limb and the wounded region above the dressing with a kind of bandage of Scultetus, formed of large bands of carbolized gauze. Another piece of impermeable placed above assured me that the fluids which ran from the dressing, being received by the carbolized bands, could not putrefy. In the first days of treatment one cannot take too many precautions, when the discharge of fluids is abundant.

The dressing is evidently as favorable to the repair of bone as to that of the soft parts, and one is surprised to see that the necessity for immobilization is only relative. Obviously the bony fragments should not be disturbed by large movements. But while authors attach great importance to the

immobilization of a compound fracture, we find here that with small movements and an apparatus moderately immobilizing, consolidation goes on well, and no inflammatory complications result. This fact is of essential value in the treatment of certain fractures. I have even acquired the habit, in cases of fractures into or near joints, of not immobilizing completely, in order that I may try to preserve the articular movements.

In 1877, at the Hospital of Lariboisière, I treated in this manner a man who had a fracture just above the right elbow, with considerable crushing of the integuments, from being run over by a carriage. It was put up in a gutter-like splint, and, every time it was dressed, movements were made in the joint. The healing was very rapid, the callus was perfectly solid, and he had sufficiently extended movements of the elbow when he was discharged. I attach importance to this fact, because I am one of those who believe in the influence of the immobilization upon rigidity of joints.

The progress of compound fractures is remarkable. At first, there is an abundant discharge of blackish serum; in the following days the serum becomes turbid; sometimes it approaches the appearance of pus, without becoming creamy; then, as cicatrization goes on, there is no longer any discharge from the wound excepting a slightly viscid serum, strongly resembling synovia; finally the discharge dries up and the wound is closed. If the bone is extensively shattered, this discharge lasts some time; it is seen in bad fractures of the leg. But if the break is not extensive, reunion is rapid and is accomplished absolutely by first intention.

This very happy progress of fractures is observed in shafts of large bones, in small bones, and fractures into joints with the same regularity. In 1877, I could show at one time in the service that I directed at the Hospital of Lariboisière, a

fracture of the lower end of the humerus, opening into the joint, multiple fractures of metacarpal bones and phalanges in a crushed hand, a fracture of both malleoli communicating with the articulation, and a fracture of the femur extending into the knee-joint. All these patients simultaneously recovered without suppuration and with the preservation of the movements of the injured joints. The cases in which suppuration continues are exceptional, and, in the greater number, our failure is to be attributed to the impossibility of sufficiently purifying the cavity.

The most formidable compound fractures are seen in military practice, and our chief concern is to keep infection from the wounds before they can be treated in a thoroughly antiseptic manner. Nussbaum, who says that "the fate of a wounded man depends almost entirely upon the physician who treats the wound during the first hours," is of opinion, like the greater part of German surgeons, that the best thing to do is to furnish the soldier with a tampon of salicylic wadding or jute, tied up in a piece of salicylic gauze. The tampon being immediately applied to the wound protects it, and the salicylic acid, dissolving in the discharged fluids, prevents infection. The first immobilizing dressing of the limb ought to be made without examining the wound, since the patient, in the ambulance or hospital, can have the benefit of a perfectly antiseptic method, which is impossible upon the battle-field; and a wound which has not been opened in any way will not receive any additional poison.

CHAPTER XV.

OSTEOTOMY.—RACHITIC CURVATURES AND GENU VALGUM.—FRACTURES OF JOINTS.—RESECTION IN FALSE JOINTS.

AN operation which consists in deliberately making a compound fracture, and that, too, generally merely for the correction of a deformity, was incapable of full development until one could be assured that this wound, if sufficiently protected, would expose the patient to no greater danger than would a wound of the soft parts in like circumstances. Nowadays we do these operations fearlessly, even if they open more or less extensively into joints. In the beginning of his antiseptic practice, Lister set the example, since often followed, in the case of a man who had outward luxation of the foot. He cut down upon the vicious callus, laid the articulation freely open, straightened the foot, and obtained perfect healing without suppuration.

Some years after he made an operation of the same kind for a vicious callus of the elbow which prevented extension of the limb. He opened the joint, excised the exuberant material, and the patient recovered without any drawback, and regained all the movements of the member.

Resection of a vicious callus may be easily made, and a few days are sufficient to insure healing. Dr. Périer recently showed the Surgical Society a young man on whom he had operated for a bad callus of the clavicle, which threatened to perforate the skin. He excised all the prominent portion, and in a few days the healing process was completed, union having been obtained by first intention.

Section, with or without excision of a wedge-shaped fragment of bone, has been practised for the purpose of straightening rachitic curvatures of the lower limbs, to correct genu valgum, and to relieve ankylosis of a neighboring articulation.

In genu valgum, the operation is done by making a section of the articular surfaces in order to displace a condyle, or by removing a portion of bone to straighten the limb, the joint being opened or not, as the case may be. Although these operations were made prior to the introduction of the antiseptic method, they were not really justifiable.

The directions, which a surgeon who does these operations antiseptically should observe, are as follows:—

Instead of striving, as formerly, to make the incisions as small as possible, so that the operation may be more or less subcutaneous, we make large openings, which allow us to freely uncover the bone, and make the section of it in the best possible conditions.

Formerly, the saw was regarded as much more dangerous than other instruments, but we do not now consider it an important factor in the production of septic complications. However, to insure perfect results, it is indispensable that all particles of bone should be washed out of the wound.

Finally, we must make sure that the drains do not interpose between the osseous surfaces which ought to be in contact, for this little accident easily happens and is a source of great irritation.

Besides these directions, there is nothing special to add. Extension, traction, movements, or fixation will be employed in all these operations, as if the antiseptic method were not used.

In making operations of this kind, it is well to remember a case reported by Lister in the *British Medical Journal*,

in 1877. It was a recent fracture of the patella, with considerable separation of the fragments, and the operation consisted in opening the joint, emptying it, carefully cleansing the pieces, suturing them together with silver wire, and draining the articulation with a bundle of horsehair. In three weeks cicatrization was complete, but he waited until consolidation was perfect before he withdrew the wire. He has repeated this operation successfully on old fractures.

Resection for the relief of false joint, also, has become an operation free from gravity, and, with the addition of the antiseptic protection, may be successfully performed in the same manner as formerly. I saw a beautiful example of this — a pseudarthrosis of the femur — in the service of Lister, in 1875. But we must not lose sight of the fact that the antiseptic method reduces to their minimum the phenomena of irritation in a wound. Now, it happens that, while the osseous extremities need to be excited in order to form the callus, the reaction is insufficient, and the wounds heal rapidly without our obtaining the desired result.

Three years ago I operated upon a man for false joint in the right humerus. In spite of very extensive resection of the fragments, in spite of the pulling and bruising of the soft parts during the operation, at the end of eighteen days cicatrization was perfect, without the patient's having had a touch of fever. But the mobility was not relieved; in spite of sufficient juxtaposition of the parts, no callus was formed.

Other surgeons have had the same experience, and, following Volkmann, we have established the following principle. During the first days we dress antiseptically, until danger of the more serious complications is past. Then, while there

remains only a moderate passage between the ends of the pieces, we abandon the antiseptic method, and let the infected air enter the cavity sufficiently to excite osseous secretion.

Most operators, however, insist upon the necessity of fastening the fragments, either by metallic suture, a peg of ivory, iron nails plated with tin, as recommended by Nussbaum, or a silver screw, as Langenbeck advises. When the fragments are united with these large and irritant bodies, a sufficient formation of callus is provoked by their presence, and we can dispense with the introduction of septic air, which is always a disturbing procedure.

CHAPTER XVI.

AMPUTATIONS AND DISARTICULATIONS.

THE greater part of the dressings which are at all comparable to the Listerian were only intended for amputations at first, as, for example, the Bordeaux and the wadded dressings. As we have already seen, the Lister method in amputations is only a particular application conforming to general rules. These rules have produced so profound a modification in the phenomena of repair that they have largely changed the conditions of amputations. Not only do the subjects of amputations recover, but the ease of recovery is such that the surgeon is much more at liberty to select the operative procedure in the best interests of prosthesis, and to employ methods to which, until now, there were objections.

Thus, flap methods are reckoned first, and the procedures of Marcellin Duval, which have been applied mathematically at all points of the limbs for the formation of large flaps, are in the foremost rank.

This is susceptible of easy proof, as I can show with respect to amputation above the malleoli with a large posterior flap, in a private patient at the present moment. Several times I have done Guyon's operation, which, while it differs in its details from that of Duval, is based upon an analogous principle to that which constitutes the general method of the eminent naval professor; and I am competent to judge after what I have observed of the behavior of the large posterior flap.

I was able to show the Surgical Society the very remarkable results which I obtained in a wounded man, who recovered in twenty days. There was linear union of the flap, the parts were perfectly flexible, there was entire absence of inflammation about the bone, and the patient walked about upon the flap with the aid of a very simple apparatus of Werber's.

In this amputation I have recommended and practised excision of the nerve trunks, as has already been advised in amputations. Here, where the patient has to walk upon a flap in which there is a large nerve, I consider this step much more necessary, and twice I have excised the posterior tibial as high as possible. The results have been excellent, and I am pleased to see that Guyon has adopted this step in his operation. Soon after, I operated upon a man in disadvantageous circumstances, and I observed the same regularity of scar and perfect flexibility of flaps at the expiration of twenty-four days. Guyon has made the same observations in his cases.

So, taking these cases of perfect, permanent union of large flaps as examples, I say that there is no longer any objection to making them as Duval proposed; and I am of opinion, also, that excision of the nerve trunks augments the serviceableness of the stump and diminishes suffering during treatment.

What, then, are the rules to follow in applying the antiseptic method to amputations? Choose those methods of operating which make the application of sutures easy; endeavor to prevent everything which can interfere with union; retrench tendons and aponeuroses, and superfluous muscular tissue in the flaps; make a high section of the bones;¹ take

¹ The over-heating of the bone, which is believed to stand in a causative relation to the necrosis of the surfaces which occasionally occurs, may be largely avoided by pouring weak carbolic solution over the saw during the section.

pains with the suture, and, above all, drain by one, two, or even three tracks.

The deep suture is not at all a necessity of the dressing, indeed is only occasionally called for, as when flabby flaps need to be held together, when the flaps are insufficient, as happens sometimes in amputations after traumatism, etc. I think I have never used it more than twice in large amputations. I may add that I have seen a pseudo-Lister dressing in which union was completely prevented by the fault of these deep sutures.

Drainage may be well insured generally by two drains at the base of the flap; but if it is large, a third may be necessary. The drains may go close to the bone, but should not irritate it; and it is well to shorten them as soon as possible in order to avoid the danger of their remaining in contact with it. The opposite practice was formerly followed by those who used drains in stumps.

Gentle compression is often very favorable to union. I do not agree with Volkmann in thinking it desirable to make it very firm, and I usually employ in amputations layers of pressed sponge which have been soaked in the strong solution of carbolic acid.

Close watching of the sutures and drainage is more essential here than in other wounds. We must not remove the clots, or worry the flaps, or make injections under them; but we should favor drainage of fluids, and cut the stitches as soon as they begin to irritate the skin or provoke the formation of a little pus.

Disarticulation wounds ought to be treated exactly like those of amputation in the continuity of limbs. The throwing-off of the articular cartilages by suppuration is not a necessity, as we find that these wounds close like the others. They are not more dangerous than other amputation wounds, but

they should be drained with particular care. In all great amputations there is need of providing good drainage; and many surgeons, only half doing this, have failures which are a decided contrast to their success in operations upon less extensive surfaces.

Great pains should be taken with the spray, which ought to envelop all the parts involved. And in the subsequent dressings, too, I advise especial attention to this point.

All the statistics of experts in this practice contain reports of large disarticulations, even that of the thigh, which have healed just like the smaller amputations. One of the most interesting of my cases occurred in the person of a little girl of six, in the Saint Eugénie Hospital, on whom I performed disarticulation at the left shoulder. She had been run over by a street-car, and the injury was so extensive that I was obliged to make my amputation right through the mangled tissues. I employed the procedure of Larrey, carefully excised the nerves, and put in six metallic sutures. At the second dressing, which was made on the fourth day, union seemed to be complete. The stitches and drain were removed on the sixth day. At no time did the dressings cause any pain.

In the treatment of amputations, it is particularly important to persist in the dressings until cicatrization is perfect. For lack of this precaution, one often meets with tedious complications, such as osteo-periostitis, pain in the stumps, and fistules. I have previously mentioned this fact in speaking of the duration of the dressings, but it cannot be repeated too much, for that is not a moderate advantage of the method which protects those who suffer amputation from all the accidents which are likely to embitter their existence.

CHAPTER XVII.

WOUNDS OF JOINTS.—REMOVAL OF FOREIGN BODIES.—OPERATIONS FOR FRACTURES AND DISLOCATIONS.—OPENING OF JOINTS FOR HYDRARTHROSIS.—OPENING OF DISEASED JOINTS.—OPENING OF WHITE SWELLINGS.—ANTISEPTIC IRRIGATION OF INFLAMED ARTICULATIONS.

IN all surgery there are no cases which more thoroughly demonstrate the value of the antiseptic method than those involving the opening of joints. Doubtless it sometimes happens that articular wounds heal without complication in favorable media; but when the circumstances are bad, it is only exceptionally that we have happy results. It is also true that, in a very recent period, the great care bestowed upon surgery has had the effect of diminishing the accidents of articular injuries; but up to the present time there has been no surgeon who could, without anxiety, contemplate the opening of a large joint, whether the result of accident or made by the surgeon himself.

Three principal accidents are feared as the consequences of such wounds.

First, traumatic arthritis, so likely to be followed by rapid and formidable accidents, general involvement of the system, purulent infection, and speedy death.

Second, interminable suppurations, within and around the joints, terminating in indefinitely delayed recovery, or death at a distant date.

Third, loss of the functions of the joint, if healing does take place, even in the favorable cases.

Just imagine that, after the employment of the antiseptic method, the wounds do not inflame, do not suppurate, and that purulent infection is unknown, and you will understand how it is that the healing of articular wounds has become the regular thing, and that the opening of joints by the surgeon deserves to rank among the operations which are safe, and as regards death, harmless.

Articular wounds.

Wounds of joints form a very bad class, especially if they have continued a considerable time without proper treatment, because we cannot then be sure of expelling the germs from all the recesses. This is a point of vital importance. The sinuosities of the wounds should be very carefully washed out with a powerful antiseptic, the strong carbolic acid water ordinarily answering this purpose. In certain cases a stronger liquid may be indicated, and then we may use a twenty-per-cent. solution of carbolic acid in alcohol. In these, as in all tortuous wounds, the injected liquid must all be evacuated, or else there may be excited too intense irritation and the carbolic-acid poisoning which has sometimes been observed. Where the wounds are so sinuous that it is difficult to purify them, we should not hesitate to lay them freely open. Great attention should be bestowed upon the stitches, which ought not to be too tight.

Drainage must be abundantly provided, and it is better to use several tubes than only one. If the wounds are very simple and straight, they will rapidly heal, and drainage is of brief duration. I advise never closing them completely at first. When they are not simple and straight, it is wise, after withdrawing the drain, to close them only when the serous secretion is very moderate in amount.

I need not dwell upon the practice and give examples of this treatment, because it differs so slightly from that which I have recommended in case of compound fractures, especially those which involve the joints.

Operations.

The operations which are performed upon healthy articulations, or those which are nearly so, are particularly interesting. I shall make no reference to the cases in which the articulations are opened in the course of an operation in the vicinity, and those in which an exploratory incision is made, as proposed by Annandale.

Removal of foreign bodies.

The facts concerning the direct extraction of foreign bodies from joints, laid open for this purpose, are certainly very curious.

We know how good reason there formerly was for considering this an operation of a serious character. B. Bell, indeed, thought it even more dangerous than amputation of the thigh at the upper third. Now, following the example set by Lister ten years ago in Glasgow, in case of a large foreign body in a joint, Barwell, in London, has made a very careful study of the value of the antiseptic dressing. But Saxtorph, of Copenhagen, by a considerable number of operations, has shown its possible success better than anybody else. He has reported twelve cases with only one death, and in this case, too cruelly illustrative, the patient tore off the dressing and was attacked with purulent infection.

Following in these footsteps, I removed at the Hospital of Lariboisière, on the twenty-eighth of October, 1876, a large

foreign body, performing a very unusual operation, that of extracting a body from the back part of the joint. An incision on the outside of the popliteal space permitted me to reach the body, which was deeply situated. The patient, a man of fifty-one years, had only four dressings; the wound was healed in nine days, and he could support himself upon the limb in three weeks. The mobility of the articulation was not in the least impaired.

The points to be observed in this special case are as follows: make a free opening; take as many stitches as are necessary to effect apposition, and take them deeply, as the tissues in this region are generally thick from close intersection. The drainage must be carefully made, and it should not last long. In my opinion, it was because he neglected drainage in the first place that Eugène Boeckel lost the patient whose history he gave in the *Strasbourg Medical Gazette*, in October, 1877. His first operation was successful, but in the second case the patient succumbed to purulent infection.

I consider it not only useless, but even injurious, to rigorously immobilize the limb after the operation. I put it all dressed into a trough, and remove it at each dressing. There is little need of renewing the dressing, except upon the first day. The operation in itself is simple. The wound is to be washed in carbolic-acid water, which, however, should not be injected into the joint. Not to uselessly irritate the articulation and not to immobilize it are two important factors in the prevention of all tendency to ankylosis.

Without any question, this is the operation to choose in the cases where there are foreign bodies in joints. The operation of Goyrand is difficult and murderous, although less serious than the old method of freely laying open, as has been demonstrated by Verneuil.

Operations for fractures and dislocations.

There are certain operations upon joints which are nearly sound which, at the first glance, are appalling. Thus, Lister has often opened joints, on account of recent or old fractures which have involved them, to straighten limbs, as after luxation of the foot; to excise pieces of vicious callus, as, for example, in the elbow and tibio-tarsal joints; and, finally, to bring together by suturing the two widely separated fragments of a recently broken patella.

Moreover, we must reckon under the head of articular wounds the operations made for the cure of irreducible luxations. Volkmann did this for an iliofemoral dislocation of two months' standing. Not having succeeded in reducing the luxation, he excised the head of the femur, and his patient was healed by immediate union.

Operation for hydrarthrosis.

An operation which seems even much more rash is often practised by Professor Lister upon obstinate hydrarthroses. At first it was a singular surprise both to me and my fellow assistant, N. Gueneau de Mussy, in one of Lister's demonstrations, in 1875. It consisted of freely opening the knee joint in a case of persistent hydrarthrosis, of carefully emptying it, even inserting the fingers to accomplish this, and draining by the method described. Thus the radical cure of a hydrarthrosis of the knee was accomplished without ankylosis. Through Dr. Rice, then *interne* at the hospital, I had news of the patient referred to above. He was completely cured at the end of two months, and walked with ease. I have seen other similar cases, and Panas successfully performed this operation at Lariboisière.

The opening should be large in order to give free vent to the fluid. The outer side, being more dependent, is to be preferred for the incision. The sutures should be taken with precision, and should, if possible, include all the tissues, even the serous, and are consequently somewhat difficult to insert. At least one tube is required for drainage, and often two will be needed. The patient, as above, should be dressed without complete immobilization, and the joint moved even before the wound is healed.

The opening of diseased articulations ; suppuration.

The opening of diseased articulations gives results which one would be far from anticipating. When there is pus in a joint, a free opening permits the evacuation of all the morbid products ; sutures are made, and the wound closes, healing in from fifteen to thirty days. Here a large, bold opening should be made at the outer side of the patella, if possible ; this permits the escape of the pus and the detachment of the false membranes ; the fingers are passed under the patella to explore and to cleanse the parts ; and carbolized sponges may be introduced into the joint and wiped against the suppurating walls without fear of doing harm.

Strong carbolic water should be freely used in washing out the joint. There will generally be considerable bleeding during these proceedings, but it need give no anxiety. The return of the fluids which have been introduced should be most strictly accomplished. After this the wound is sewed up and drained almost exactly as in a case of chronic dropsy of the joint.

I have made this operation five times with remarkable results. At the Lariboisière, in January, 1877, I opened a knee for purulent arthritis in a man of thirty-three, who was suf-

fering from a sort of purulent infection. In this case, which I have seen very often since, the results of the operation were very simple. In twenty days the knee was completely cicatrized, and in three months flexion of the leg was accomplished with entire ease.

At the same hospital and in the same year, I opened the knee of a man whose only alternative was amputation of the thigh. He had osteo-periostitis of the femur, attended with the detachment of a great deal of bone. A large sequestrum and a number of completely infected abscesses prevented my maintaining the asepticity of this wound until the very end of treatment; but, for all that, after some months the patient walked out with a good use of his limb. In this case, recognizing the previous infection, I injected into the cavity, at several different times, a twenty-per-cent. solution of carbolic acid in alcohol.

Since then I have opened a knee at the Maternity for a most serious arthritis in a puerperal woman. The patient was nineteen years old and entered for her lying-in on the ninth of July, 1878. She had eclampsia, and was delivered with the forceps. After a little an eruption broke out, and several joints were seized with pain. The left knee became tumefied and extremely painful, chills occurred on the tenth of August, and again on the twentieth, the last being very violent. The limb reached an enormous size, the suffering was atrocious, and rest was impossible. The puerperal state and the extreme gravity of the local lesion constituted a frightful combination, and the general condition was miserable. On the twenty-seventh of August, an opening fourteen centimeters long was made on the outer side of the joint. The pus was abundant, the false membranes thick, and a large quantity of blood escaped into the articulation. The suffering instantly disappeared. At the end of twenty-

seven days the joint was closed, and the patient got up at the end of two months. Little by little walking became easier, but a good deal of stiffness remained in the joint five months after, the patient refusing to allow passive motion to be made. She walked very well without fatigue, gained rapidly, recovered all her movements, and found herself so well that she was unwilling to submit to even a little operation to increase mobility.

More recently, being called in consultation by M. Sée at his private hospital, I opened the right knee of a young creole who had purulent arthritis, the sequel of a deep angei-leucitis of the leg. In spite of the general and local unfavorable conditions, we obtained the best result, the knee being closed in fourteen days, with no deep inflammation of the leg, and movement of the articulation already being established.

M. B., aged twenty-two, had in the right calf an enormous abscess consecutive upon angei-leucitis of the foot, and M. Sée opened it on the fifteenth of November, 1878. On the twentieth of December, the patient began to have pain in the knee, the wound in the calf continuing to suppurate. The rapid swelling of the articulation and the repeated chills left no doubt as to the presence of pus, and on the twenty-seventh of December a needle was inserted and a moderate quantity of pus evacuated. Three days after, the knee had attained a great size, and the general state was bad. An opening ten or twelve centimeters long was made on the outer side of the joint, and was followed by the escape of pus and false membranes. I passed my fingers into the articulation, washed it out with strong carbolic solution, and sewed up the wound, excepting the upper angle, in which I placed two drains side by side. The discharge for the first two days was abundant, but afterwards there was merely an exudation of serum. The drains were removed on the ninth of January,

1879, the sutures on the tenth, and on the twelfth cicatrization was complete. The development of a new abscess in the calf interfered with the healing, and the pain which it produced prevented the patient's permitting sufficient flexion of the knee. However, in April he began to bend it well.

At the Salpêtrière, in the service of my colleague, M. Terrier, I operated upon a woman of thirty-seven years, the beginning of whose arthritis dated back to the puerperal condition, after a miscarriage in the first part of December, 1878. She had had abscess in the calf, and in December, June, and January she developed purulent arthritis in the left knee. From the fifteenth of January to the twenty-third of May she was under the care of Professor Gosselin, who punctured the knee and drew out some pus. On the twentieth of April she entered the Salpêtrière in the service of M. Terrier. The left lower limb was in a very serious condition, the tumefaction being enormous, the pain unendurable, the fever high. The limb was actually deformed, the fluctuating accumulation rising up eighteen centimeters above the patella. On the twenty-third of April, I made an incision eight centimeters long on the outer side, and more than a liter of pus and false membranes gushed out. I washed out the cavity without passing my fingers under the knee-pan. The bleeding was profuse. I made another incision on the inner side, parallel to the first. Then I sewed them up, leaving only enough room for a drain on each side. The tracks of the tubes did not cicatrize until the thirteenth of June. When the patient was discharged, on the twenty-sixth of July, she walked well and was able to flex her leg to a right angle.

I dwell upon these examples in order to give the reader a proper comprehension of his resources. It may be claimed that by no other proceeding could such results have been obtained; and yet they might have been more rapid, for almost

all the operations were made in circumstances which were only moderately favorable, and in services where the attendants were not accustomed to this mode of dressing.

After having given a fair trial to the trough, I have come to the conclusion that it is almost useless, and that immobilization may be dispensed with—a great advantage in most cases, since it enables us to establish motion in the articulations almost immediately. In the numerous cases of articular suppuration and of epiphyseal osteo-periostitis, I think we may practise it with profit, freely opening the abscess and boldly trephining the diseased bones.

The opening of white swellings.

An operation which seems to give excellent results is that of making large incisions into joints which are attacked with white swellings. Sometimes, as Lister says, this suffices to start the patient on the road to recovery. I have practised it with success. If, after some time, there is no amelioration of the patient's condition, resection should be resorted to.

Unfortunately I have not been able to keep track of the patients upon whom I have practised such incisions. I incised the elbow of a young woman, a private patient, and she got along admirably during the two months I was able to keep watch of her. Saxtorph has reported cases of this kind. Concerning the operation itself there is nothing in particular to say, as it does not materially differ from that for articular abscess. The dressing should not be abandoned until cicatrization is absolute.

The antiseptic irrigation of inflamed joints.

Schede has recommended an operation which can be practised freely upon inflamed joints. It consists in puncturing

the articulations which are attacked with rheumatic inflammation and distended with excessive secretion, then emptying them, injecting weak carbolic solution, and repeating this injection until the fluid returns clear. The canula is then withdrawn and the limb is immobilized. This little operation, being made with all the antiseptic precautions, is without danger, and is followed by relief and rapid recovery. It is now so extensively practised in Germany that it is even done in cases of acute rheumatism, when there is much swelling of the joints.

The manner of operating is as follows: all the antiseptic precautions being observed, the puncture is made with a medium-sized trocar; a two-and-a-half per cent. solution of carbolic acid is then thrown into the joint; after this escapes, another injection is made, and this process is repeated until the discharged liquid is clear.

After the operation the reaction is variable. Some patients have none; others have some swelling, at first painful, afterwards a little persistent.

The results of this practice are excellent. Carl Rossander, of Stockholm, who has followed Schede, praises it highly. He has even employed it in the case of a child a year and a half old.

CHAPTER XVIII.

RESECTION OF JOINTS.

FOR a long time French surgery hesitated before this class of operations; for, while resections of the elbow, shoulder, and ankle were often practised, those of the knee and hip were very rare, and those of the wrist were almost entirely avoided. The legitimate reluctance of conservative surgery ought to give way before the antiseptic method.

Resections may be rejected on account of the immediate accidents or the protracted suppurations which follow them; persisting fistules and loss of the functions of limbs are the direct consequences. Most of the dangers are immediate, and secondary accidents are very rare; and, therefore, we should be very favorably disposed to these operations.

Generally they present nothing in particular which requires any modification of the dressing. Nevertheless, it should be remembered that we have to treat inflamed joints which have not and those which have exterior openings. Quite naturally, in the latter cases it is much more difficult to obtain asepsis; but yet we can secure it very frequently by scraping the suppurating surfaces with a curette. In these cases, and even in those which have not had an external opening, it is always necessary to carefully remove all morbid products. This is the one step in the procedure upon which success depends. The fungosities must be completely destroyed; for, if they are left in place, they multiply rapidly, impede reunion, and provoke suppuration. The surgeon cannot be too scrupulous in cutting them away even to the last traces.

In the case of certain articulations, as the knee, for example, Volkmann goes much further, and advises the careful removal of the fibrous tissues, which often hinder reunion. The drainage is difficult, and it should be made with the utmost fastidiousness.

For resection of the hip and shoulder there are no special indications. I have seen Lister effect drainage with horse-hair with good results. Extension may be practised from the beginning of the treatment.

In the knee we have the advantage of obtaining solid union, and particular pains should be taken to avoid non-union, which makes a genuine pseudarthrosis, arising from the lack of inflammatory reaction. I pointed this out in speaking of the treatment of false joints.

In a communication to the Congress of German Surgeons, Volkmann recommended suturing the osseous surfaces. He considers the catgut the best material for this purpose, and leaves it permanently in the wound. Silver and iron wire have also been used with good results.

At the same time, Volkmann advised the avoidance of the use of the saw in articular resections. The bones of people who require excision can be cut well enough with the knife, and the surface obtained in this way is much better adapted for reunion, as the action of the saw leaves an osseous surface of which a thin layer may mortify.

Excision of the wrist was strongly advised by Professor Lister long before the antiseptic method was proposed; and so it was all ready to profit by the resources of the new system. I have watched his patients in all stages of treatment, from the moment of operation until the cure was complete. Here the object of the surgeon is to preserve both the form of the hand and the greatest possible amount of movement; and, therefore, the professor recommends the employment

from the first of a kind of splint of cork with a marked convexity, upon which the palm of the hand rests. Then, after a few days, say at the end of the first week, he makes the patient perform the various movements of the fingers at each dressing, and this, he says, is the true means of getting good results from the operation. Thanks to the asepticity of the wounds, this practice of movement, at a very early date, may be employed whenever we desire to have a movable joint after resection.

The most salient circumstance in the progress of wounds of this sort is the extraordinary rapidity of repair, in illustration of which I may mention a knee healed in fifteen days under the care of Professor Lister. Auguste Reverdin recently reported to me that he had actually observed in these cases union by first intention. He had seen a child in Volkmann's service, whose wounds were cicatrized in five days after resection of the hip.

CHAPTER XIX.

PERITONEAL OPERATIONS. — STRANGULATED HERNIA. — RADICAL CURE OF HERNIA. — LAPAROTOMY. — OVARIOTOMY. — CÆSAREAN SECTION. — PORRO'S OPERATION. — CYSTS OF THE LIVER.

ALL operations which involve the peritoneum have a common character, whatever differences they may present; and I introduce them in the same chapter, because the antiseptic method is similarly advantageous in all of them. If the method is rigorously practised, the opening of this great serous cavity is deprived of its proverbial seriousness. Steam spray-producers are particularly necessary in these cases, and those apparatuses which chill or wet these great uncovered surfaces too much are objectionable.

Kelotomy; operations for strangulated hernia.

In the front rank of operations which every practitioner is called upon to make we must place that performed for strangulated hernia. I have done it a great many times with the antiseptic method, and the results have been excellent, though sometimes almost un hoped for. As there is no local inflammatory reaction, the chances of peritonitis are insignificant, the repair of the injured parts is accomplished more rapidly and regularly, and the reduction of the rupture is allowable even when the appearance of the intestine is very unpromising.

I had been previously pretty fortunate in my hernia operations, in which, however, I always employed antiseptic washings and closure of the wound; but I never happened

to have six cures one after another, as occurred in the year 1877, under the antiseptic treatment; and of these six some were miserable cases, both as regards the age of the patients and the duration of the strangulation. Since I began to use the Lister method, I have lost only those cases in which there was so serious an injury to the knuckle of intestine that perforation rapidly took place. My operations have been only on persons brought tardily to the hospital by day or night, generally after having been subjected to violent and prolonged taxis, and it is on this account that six consecutive cures are so remarkable.

The irritant action of the carbolic acid upon the peritoneum has been dreaded; and yet it is marvellous to see that a solution, so strong as to destroy the epidermis on the operator's hands, is borne by the peritoneum without inconvenience.

In the operation for strangulated hernia, in addition to the ordinary precautions, I recommend a large opening, so as to completely uncover the sac. As soon as the sac is opened, its cavity should be washed out several times with the strong solution in order to neutralize the products of inflammation or hemorrhage of the sac and get them out of the way. Then we proceed to the removal of the constriction, which being done, the loop of intestine is carefully washed with the weak carbolic solution, before being returned to the abdomen. With it some of the carbolized water always enters the abdominal cavity, but it is of no consequence. Before the suture is made, I advise the excision of the greater part of the sac, as this proceeding greatly facilitates union, and is of advantage with reference to a radical cure. Great care should be devoted to the stitches. For a long time I have been in the habit of taking a deep stitch at the level of the ring. This practice favors radical cure, but it requires a

great deal of watchfulness, because it is followed by a little swelling. A single drainage-tube suffices, except in large scrotal herniæ. There is no need of keeping the tube in a long time; it should be removed some time between the fourth and eighth days; and thus the cure of a strangulated hernia does not generally take more than from eight to twelve days.

In this way the operation is made with great ease, and with entire absence of concern as regards proximity to the peritoneum; indeed, in my hospital services, I always give the students a good understanding of the operation, by making them put their fingers into the wound, and even into the peritoneum, behind the open ring, provided they have cleansed their hands in my presence. Sometimes there are seven or eight around me who make this deep examination, which has never yet, to my knowledge, resulted in any harm.

Several times cases in which the intestine was injured and even perforated have presented themselves. Panas once had occasion to apply a ligature like the string of a purse to an intestine which had become gangrenous at one point; then he reduced the hernia, and the patient made a good recovery.

I have always taken advantage of the occasion for this operation to make that for radical cure, and whenever there are large masses of omentum, I cut them off, and reduce the one or more pedicles tied with catgut.

I have generally made the sutures with silver wire, but I have also used catgut, and have very lately had an excellent result in the case of a woman, who was out of bed in less than three weeks after the operation.

As regards the dressing, I would particularly direct the attention of the reader to the difficulties of applying it in the fold of the groin. We have to make it thick and to complete

it at the edges with boracic wadding or lint. The amount of discharge is so moderate that very infrequent dressings will be found sufficient. The early omission of the drainage and the use of catgut for sutures are favorable to rapidity of healing.

In order to insure the maintenance of the radical cure, I always make the patients wear a bandage for some time after the operation. It seems to me that, since I have employed the proceeding indicated, the radical cure has been the rule, while, in my first operations, recurrence of the difficulty was most common.

Radical cure of hernia.

This operation will soon take its place in the rank of legitimate surgery, both on account of the security acquired by the employment of Listerism, and from the possibility of employing without hesitation convenient and really efficacious methods. The publications on this subject are already numerous.

One of the first and most brilliant of the published results was that of my friend and companion, Dr. Chiene, of Edinburgh, who effected the radical cure of immense epiploïc herniæ.

The essential steps of the operation are as follows: incision of the sac; subdivision of the pedicle of the epiploïc mass into little bundles, each of which is tied with catgut; excision of the omentum below the ligature. This being done, the pedicles are reduced. The whole of the sac is resected, the neck is closed by deep catgut sutures close to the ring, then superficial silver sutures are inserted, and drainage effected as in case of strangulated hernia. Chiene has made this operation successfully several times already.

I myself pursued this plan in taking advantage of a keloto-

my made for a left, strangulated, crural hernia, accompanied by an omental mass as large as my fist. I relieved the constriction, reduced the strangulated knuckle of intestine, divided the epiploïc pedicle into seven fasciculi, excised the entire mass, and replaced the pedicle within the ring. Then I cut away all the sac, and sewed up the neck with deep silver stitches. The patient was cured in three weeks; and when I examined her, several months afterwards, she had had no return of the rupture. The catgut threads had been cast out, which I attributed to the premature abandonment of the dressing; the patient was not in my own service, and I did not personally superintend her case. Three months after, I did the same operation upon a woman sixty years old, who was up and about in three weeks, wearing a bandage.

Dr. Henry O. Marcy, of Cambridge, Massachusetts, has published an interesting treatise, in which he recommends operating without opening the sac. The sac being exposed, he replaces it within the ring with his finger, and fastens it in place with catgut sutures, passing them at the level of the neck. This operation he has performed twice in cases of strangulated hernia and once in an uncomplicated hernia, with complete success in the first two, and partial in the last.

The most complete publication is that of Professor Tilanus, of Amsterdam. He shows by statistics that the operation for radical cure, even when performed antiseptically, is not absolutely free from danger, and he thinks that it ought to be employed only in irreducible or otherwise complicated herniæ. In performing it, he advises the excision of the sac, the suture of the deep parts about the neck, and a superficial suture. He has tried the plan of not making the patients wear a bandage immediately afterwards, but his experience was not satisfactory, and he now favors the use of the bandage. He

does not approve of complicated procedures, and considers the use of injections as insufficient. Tilanus's work reviews all the important facts which bear upon this subject, particularly those brought forward by Czerny.

The same dressings should be used as in strangulated hernia. It is a good plan to make a number of incisions about the ring, a sort of scarification. This, combined with complete excision of the sac, permits the deep suture to effect an approximation of surfaces which are raw and bloody. Drainage is called for, but should be dispensed with as soon as possible. The deep suture which includes the ring may be made either by tying the two ends and leaving them deep in the wound, or by bringing the two principal threads out and securing them on the skin, which is my method of doing it. The suture should be carefully watched, as it sometimes excites swelling. The stitches are much more easily taken in inguinal hernia.

Umbilical hernia affords an especial opportunity for anti-septic surgery. It is no longer a matter of such gravity as it was formerly, and the excision of the sac is particularly easy. We know that in ovariectomy, when there is a co-existent umbilical hernia, it is the rule to excise the sac and the adjacent skin; it is a simple procedure for radical cure which should be used in cases of umbilical hernia.

Professor Carl Rossander, of Stockholm, performed very nearly this operation for umbilical hernia in a child of two years, in 1878. He opened the sac, excised the omentum, ligatured the sac, retrenched it and the pouch of skin, and sewed up with catgut, using no drain. The cure was immediate; and, several months afterwards, there had been no return of the difficulty.

Laparotomy for internal strangulation.

The opening of the abdomen to seek for the seat of a strangulation, whether we are guided by the data of an exact diagnosis or proceed very much at random, has become an excellent operation, for the reason that, on the one hand, large abdominal incisions are no longer serious, and, on the other, even prolonged search under antiseptic protection does not tend to awaken inflammation. This is the opinion of almost all surgeons who are familiar with the antiseptic method, and antiseptic laparotomy has achieved numerous successes in England, Germany, and Denmark.

My colleague and friend, Dr. Terrier, in 1877, made at the Bicêtre a laparotomy for internal strangulation upon an old man of sixty-three years. In spite of his alarming condition, the patient was completely cured in ten days.

Recently I assisted Dr. Terrier in a laparotomy on a young woman of twenty-one, two months after her *accouchement*. She had well-located pain of an unbearable character, vomiting, a pinched countenance, and low temperature. Both of us diagnosed strangulation by a loop of peritoneum. The incision was made in the linea alba. There was bloody serum in the abdominal cavity. The operation was very laborious and occupied nearly an hour and a half. Dr. Terrier was obliged to pull out a large part of the intestines before he could reach the constriction, which was found in the true pelvis. It was lifted up on two fingers and torn, and the abdomen was rapidly sponged and closed. The patient recovered in a few days, and, after the operation, complained of no pain in her belly. In this case, as in the former, the spray was furnished by my apparatus. The operation was made in the common ward, without removing the patient from her bed.

These two cases may be taken as remarkable types; analogous cases are easily found to-day. Antiseptic laparotomy for invagination of the intestines has often been performed; the gut having been unwound, the cure is immediate.

We should also remember the beautiful operation of Studsgaard, of Copenhagen, who, in a case where a glass vase had been put into the rectum and had passed into the colon, whence it could not be extracted through the natural passage, incised the abdominal wall, opened the intestine, removed the foreign body, sewed up the bowel with catgut, returned it to the belly, and closed the external wound. The patient recovered rapidly.

The antiseptic method has made this searching for foreign bodies a practical and, in difficult cases, a valuable resource.

In operations of this kind, certain directions should be followed. To have them successful and rapid, we must make a bold incision in the abdominal wall, and I advise making it always in the median line. As I have remarked elsewhere, these large incisions give us a chance to search without hindrance from the intestines, even when they are tympanitic. Several incidents in my own experience warrant me in making this assertion; but I have never had better proof of it than in a laparotomy which I made on an old woman of eighty, who had an internal strangulation coincidently with an uncomplicated hernia. The tympanites was enormous. I made a large, median incision, and readily reached the constriction. Unfortunately, such was the condition of the intestine that there was no chance for a successful result; but I had found an almost easy operation, where I had feared it would be difficult.

The draining of a little carbolized water into the peritoneal cavity is not a matter of great moment; but, nevertheless, it is prudent to cover the edges of the wound with moist com-

presses, which will prevent the too abundant entrance of this liquid into the abdomen. All the viscera which are exposed to the air ought to be scrupulously washed with the weak solution. The ligatures may be made of fine carbolized silk, or, better still, of good catgut.

Finally, in the majority of cases, drainage is useless. We close the abdomen completely, as in ovariectomy after the pedicle has been dropped back into the cavity.

Ovariectomy.

It was obvious that ovariectomy would be happily influenced by the antiseptic method. I do not know who first made a complete application of it; perhaps it was Newman in 1872. Nussbaum, of Munich, seems to have been one of the first to practise it thoroughly, using the spray, bathing the peritoneum with the weak solution, and draining the abdomen with a bundle of eight tubes inserted upright near the pedicle. Immediately his results, which had been no more than moderately good up to that time, became excellent; he cured eight patients in succession, a thing which had never happened to him before. Volkmann made an operation in 1873. Howitz, of Copenhagen, began in December, 1875, in his seventy-seventh operation. He had been having a series of hopeless failures; he adopted the method, and at once had nine consecutive successes.

In Germany, ovariectomy never gave anything but moderate results until the antiseptic method was introduced; and the most brilliant evidence of the advantages of Listerism is in the article of Schröder (*Berliner Klinische Wochenschrift*, 18, March, 1878) on fifty antiseptic ovariectomies, in which he shows that the mortality was reduced from fifty to twenty per cent.

The documents upon this subject are now very numerous, and it would be necessary to devote a considerable chapter to their mere enumeration, for almost every country contributes some. I must content myself with pointing out two articles of capital importance, which are to be found in the British Medical Journal for the 19th of October, 1878.

The first is by one of the surgeons of the Samaritan Hospital, which has been made so celebrated by the operations of Spencer Wells, and is entitled, *Fifty cases of complete ovariectomy, with remarks upon six other cases of opening the abdomen, by Knowsley Thornton*. The author, who was Professor Lister's *interne* before he became Spencer Wells's assistant, shows that, from the very day on which he adopted the antiseptic method, his operations were much improved, and while his first twenty-five cases gave seven deaths, that is, twenty-eight per cent., the following fifty, for the most part by the antiseptic method, gave four deaths, that is to say, eight per cent.

The other article is still more important, being from the Scotch ovariectomist, Keith, who has, up to the present time, obtained the most beautiful results known. He narrates how he tried the antiseptic method at first without the spray, and his results were less satisfactory than by his ordinary practice. He renounced this plan, and substituted the perfect antiseptic method, including the spray. Before that, the mortality in fourteen years had been one in seven, and, for the year immediately preceding, one in twenty-one. The first forty-nine cases with the full antiseptic method gave him two deaths, which occurred in the first eight cases. He had operated on forty-one consecutive cases without a death. The two fatal cases were of so exceptional gravity that he would probably not have attempted them without the antiseptic method.

In Keith's opinion, the method has diminished the mortality. The security which it gives warrants operation at an earlier date. Drainage is less frequently necessary, and may be more speedily dispensed with. Convalescence is more rapid. The operation is much easier, and the proceedings for the purification of the person and instruments are simpler. Finally, says Keith, the best proof that the spray is necessary in ovariectomy is my previous experience with the antiseptic method so many years without the spray.

The application of the antiseptic method in ovariectomy may be made in two distinct conditions—where the pedicle is kept outside, and where it is returned to the peritoneal cavity. It is easily seen that the latter facilitates the application of the method.

Ovariectomy is done in the ordinary way with a good steam-atomizer. All the catgut ligatures are cut short and left in the cavity. The pedicle is subdivided and tied with silk or catgut. Drainage is effected, as in the past, by an upright glass tube, through which the fluids may be aspirated from time to time. This tube should be capped with an antiseptic sponge well wrung out. Nussbaum has used a bundle of eight caoutchouc tubes for a drain, withdrawing one or two at each dressing. Vaginal drainage appears generally to be a bad proceeding.

I have not had a large personal experience in complete antiseptic ovariectomy, having done it but three times. Two of these patients rapidly recovered; the third, whose general condition was deplorable, rapidly sank and died.

I have made one hysterectomy with ablation of both ovaries for a rapidly growing sarcoma. The patient was in a most satisfactory condition, both general and local, after the operation; but strangulation took place, and she died almost suddenly on the fifth day.

In France, the antiseptic method was not at first rigorously applied in ovariectomy. Lately, my colleagues, Terrier and Périer, after having for some time employed only its principal precautions, have adopted it in all its completeness. It is hard to determine the share of the method, for the success was great all through: twenty of Terrier's twenty-two cases were successful, and all of Périer's eight. Moreover, Périer last year removed both ovaries and the entire uterus, distended with an enormous myoma which filled the abdomen, necessitating an incision which extended almost to the ensiform cartilage. The operation was thoroughly antiseptic, and the woman recovered without accident.

In making an ovariectomy, the operator should take pains to keep any considerable amount of carbolyzed water from entering the abdomen, and, if any does, to sponge it carefully away at once. During the operation, compresses saturated with weak solution should constantly be used for the protection of the incision and the viscera. Silk or catgut may be used for ligatures. In an immense majority of cases, drainage may be dispensed with. It is even dangerous, if the dressing is not proper. Without drainage the dressing is extremely simple: above the protective, several layers of moist gauze; then a very generous amount of dry gauze; and over this a mass of wadding. The dressing rarely requires to be renewed, except in case of pain.

It has seemed to us, as to Keith, that those patients who recover excellently have a little greater elevation of temperature on the first day than patients used to before the method was adopted; but that is common to all antiseptic operations where large surfaces are exposed.

Cæsarean section and Porro's operation.

The antiseptic method has enabled us to revive the Cæsarean operation in cities, and successful cases have already been published.

Disinfection of the vagina and uterus is very difficult, and perhaps the security will never be absolute, but considerable gain may be made. In these cases, in addition to all the precautions relative to the abdominal wall, the vagina should be washed out with repeated injections of strong carbolized water; a compress, saturated with the weak solution, should be laid upon the vulva, and frequently renewed.

The operation is like ovariectomy. The uterus is to be incised in place, and, after the delivery of the child and placenta, the wound is to be closed with sutures. This may be done with good, large catgut. It has been said that they cut out; but it is probable that, in these cases, the thread was too fine, and particularly that the stitches did not go deeply enough into the walls. Abdominal drainage should only be made with short tubes, placed in the lower angle of the wound; and it would be imperfect, if retraction of the uterus were to take place. According to circumstances, the drainage will be abdominal or vaginal.

The minutest precautions must be observed with reference to micturition and defecation, especially in the first days. Thick tampons of gauze and even carbolized sponges, carefully separated from the skin, may be employed with advantage.

I have had some experience in the operation of Porro, which is Cæsarean section followed by excision of the body of the uterus. Last March, Tarnier performed it in the midst of students in the great amphitheatre of the Maternity, a place which is not considered healthful, to say the least.

He requested me to take charge of the antiseptic manœuvres, which were as follows: the preparation of the abdominal surface as for ovariectomy; repeated vaginal injections with strong carbolic solution; the application of carbolized compresses to the vulva; in the course of the operation, after the incision of the uterus, the very careful *toilette* of the peritoneum with carbolized sponges; the application of a knot of iron wire to the pedicle; scrupulous dressing with gauze. After the operation, a carbolized compress was kept upon the vulva. The healing was rapid; the antiseptic dressing was not discontinued until the wound had become insignificant.

It is much easier to attain perfect asepticity in this operation than in Cæsarean section, and this is certainly one of the greatest inducements to choose it. While nobody has known of a successful case of Cæsarean section in Paris for a hundred years, the antiseptic method has given us success in an equally formidable operation in a hospital amphitheatre. I have nothing to add to the description of the precautions taken in ovariectomy and laparotomy, excepting the purification of the vagina.¹

Since this operation was first performed by Porro, of Pavia, in May, 1876, it has been made but seven times in France: once by Fochier, of Lyons, in February, 1879, mother and child being saved; twice by Tarnier, of Paris, the mothers being saved, and the infants dead before the operation was begun; and four times by myself, with the result of bringing into the world four living children, and saving two of the mothers. Of the infants, two are yet alive and well; one was killed by criminal carelessness; and the last, which was very feeble from its birth, died in four days. The two sur-

¹ The description of the author's four Porro's operations which follows is taken from a report which he sent to the translator in April, 1881.

viving mothers are in excellent health, and I presented them at the Academy of Medicine in March, 1880, when I reported all my cases.

By a singular chance these four cases of extreme contraction came under my observation in the space of two months. In each there was a rachitic pelvis, with a conjugate diameter of about six centimeters or less.

The first patient was twenty-six years old, primiparous, one meter and a quarter tall, with a sacro-sub-pubic diameter of seventy-three millimeters — a typical rachitic case. During the last three weeks of her pregnancy I had her under my care at the Maternity. Labor began in the morning of the nineteenth of November, 1879, and the operation was performed in the afternoon of that day, every precaution having been taken. The bag of waters had not broken, there was a slight bloody discharge, and the cervix was effaced. An incision fifteen centimeters long was made in the median line, beginning a little above the navel, and the womb was quickly reached. A frightful gush of blood followed the cut into the uterus, but the section was rapidly completed, and a living child weighing twenty-seven hundred grams was removed. The placenta was then extracted, and the womb was drawn out of the abdomen by means of two cyst forceps which had been previously applied to the edges of the uterine wound. Two pins were passed through the lower portion of the uterus, an iron wire was put around below, and another between them, and both were drawn tight with the *ligateur Cintrat*. Then the body of the uterus, together with the ovaries and Fallopian tubes, was removed. The stump was touched with perchloride of iron and brought between the lips of the abdominal wound, which was then closed with one superficial and six deep sutures. The perfect Lister dressing was applied. The operation lasted three quarters of

an hour. The subsequent history of the case was very simple. On the evening of the twenty-first, the highest temperature, 38.9° C., was reached. By the twenty-eighth, all the stitches had been removed, and then the pins were withdrawn. The pedicle disappeared on the second of December, and cicatrization was complete on the twentieth. In about six weeks the patient was completely cured. There is but slight abdominal protrusion, the cervix is large and movable, and she had sexual congress without accident two and a half months after the operation. In direct violation of orders, her child, when three days old, was carried from her chamber, the temperature of which was 23° C., to a very cold church to be baptized. It had previously been particularly well; but it immediately became ill, and died in thirteen days.

The second of these women was in the service of Professor Potain, in the Hôpital Necker. She was twenty-two years old, one hundred and thirty centimeters high, very rachitic, with a sacro-pubic diameter of, possibly, five centimeters. She had been in labor thirty-six hours, and the amniotic fluid had been discharged twenty-four. After having administered chloroform for several hours to quiet her extreme excitement, I performed the operation at nine in the evening of the thirtieth of December, 1879. The os was dilated to the size of the palm, and labor was in full progress. I began the abdominal incision of sixteen centimeters well above the navel, and ended it at a greater distance from the pubes than in the preceding case. Considerable hemorrhage followed the incision into the uterus. The infant's shoulder presented, but it was pushed back, and the child was extracted by the feet. It proved to be a fine boy, weighing more than three kilograms, and immediately breathed well. The treatment of the wound was like that in the

previous case. During the subsequent history the only alarming symptom was an extraordinary acceleration of the respiration (fifty-five a minute) twenty-four hours after the operation. The temperature never reached 38° C. The wound was dressed on the fifth and again on the ninth days, the pedicle dropping out of sight on the second of these occasions. By the end of January, 1880, there remained only a very superficial ulceration. She began to get up in February, and has now been well for a long time. The healing was so perfect that but little trace of the operation remains. The baby was confided to the care of one of the nurses, and is doing well.

The other two operations were fatal. One was performed at the Maternity on the third of December. The woman died in thirty-six hours; the child still survives.

The final case was in my service at the Cochin, on the seventeenth of January, 1880. The sacro-pubic diameter was forty-nine millimeters. At first the patient was in very good condition; but she had a violent nervous attack four hours after the operation, and expired in twenty-three hours. The child lived three days.

I believe that my operations demonstrate the desirability of making the abdominal incision at a higher point than has hitherto been practised; for, by keeping the wound at a good distance from the pubes, perfect asepsis is much more likely to be accomplished.

If great attention is bestowed upon the antiseptic precautions it is not necessary to have a special, absolutely pure apartment for the operation. One of my patients was operated on and recovered in a badly ventilated chamber, which had been sometimes used for the isolation of contagious diseases. The essentials are seclusion, warmth, quiet, attention, incessant antiseptic precautions, and sufficient comforts.

Hydatid cysts of the liver.

The opening of large hydatid cysts of the liver has been done by Volkmann in the following manner: he incises the abdominal wall as far as the liver, and then applies the perfect Lister dressing. Several days are allowed to pass, in which a slight inflammation excites adhesion between the liver and the abdominal wall, and then he can open the cyst and treat it with antiseptic injections.

A similar operation has been made in the case of a cyst which was very difficult to empty, by first performing resection of a rib overlying the liver, and then opening the abscess at another time.

Nephrotomy, gastrotomy, normal ovariectomy, splenotomy, etc.

I merely indicate by name these cases of antiseptic abdominal surgery; practically, the precautions which should be taken do not differ from those which we have pointed out in the before-mentioned operations.

CHAPTER XX.

SURGERY OF THE FEMALE GENITAL ORGANS. — OPERATIONS WITH PERFECT AND IMPERFECT ASEPSIS. — OBLITERATION OF THE VAGINA. — VESICO-VAGINAL FISTULA. — PERINEORRHAPHY. — ENUCLEATION OF FIBROUS TUMORS OF THE UTERUS. — ASEPTIC ACCOUCHEMENT.

It is a matter of extreme difficulty to obtain perfect asepsis in the neighborhood of the anus, vagina, and urethra ; but yet, it can be achieved in some cases, while in others the attempt will be unsuccessful. Nevertheless, by following the precepts of the antiseptic method, the surgical interference is much simplified, suppuration is diminished or repressed, and septic accidents are less to be dreaded. This is not strictly Listerian surgery, and yet it is a style of practice which is inspired by Lister's teachings. So, without going into minute details, I devote this chapter to enforcing its importance upon the mind of the reader ; the special applications he will be able to make for himself. I will begin with those operations which may be strictly aseptic, at least for a time, and follow with those which are only partially aseptic.

Obliteration of the vagina.

It is well known that the operation of opening the hymen, the vagina, and the uterus, when the menstrual fluid has been dammed up behind an obstruction for months or years, is one of especial gravity. If the opening is made without the introduction of instruments or fluid into the vagina, pow-

erful and frequent antiseptic injections diminish this gravity ; but fatal cases are unfortunately still common. In my opinion, the danger depends upon the immediate accidents, and I think that, if one can insure complete asepsis during the first few days, and the uterus has once been restored to its normal condition, the chance of accidents is only moderate.

The plan which I proposed I have twice tried with success. It consists in carefully cleansing the adjacent parts, making an opening with all the precautions, establishing drainage, and applying masses of gauze and a mackintosh. The bowels are to be confined. Twice or thrice in twenty-four hours a probe is passed with all the desirable precautions, including the spray. No vaginal injections are made. After five or six days, when the womb has returned to its normal condition, the severity of treatment may be relaxed, if the woman cannot endure the precautions any longer ; but if one can gain a few days, so much the better. Then the dressing is continued in the same way, but the patient is allowed to urinate and go to stool. But, in this case, vaginal injections of carbolized water are demanded, because the vaginal discharge immediately becomes odorous.

On the fourth of March, 1877, I operated upon a girl of seventeen, whose abdomen had been growing large for two years. At the menstrual periods the pain was intense. The lower end of the vagina was about three centimeters from the surface, as was determined by rectal examination. The fundus of the uterus had risen up as high as the navel. At the time of the operation, there escaped a full wash-bowl of altered, tarry blood, and the discharge continued extremely abundant for the three following days ; but, with the precautions mentioned, the liquid remained absolutely odorless. Thus it continued up to the fifth day, when, the uterus having resumed its natural size, the discharge was insignificant. The

strictness of the watch was abated, and from the next day the liquid had an odor. Abundant vaginal injections were then given twice a day with two-and-a-half per cent. carbolic solution, and the patient was well in three weeks, without having had any inflammatory complication. The menses were regularly established, and this young woman, who was married in November, 1878, was delivered without difficulty of a beautiful child on the twenty-fourth of September, 1879.

In another case, the blood found an exit beside one of the labia majora, a little before the hour fixed for the operation. Nevertheless, I was able to apply an antiseptic dressing, and the first days passed as in the first case, without bad odor, without putrefaction of the confined fluid. At last, on the fifth day, I stopped passing the probe, and on the morrow the discharge began to smell. The artificial opening was enlarged by an incision, and the patient recovered. For more than a year her catamenia have been regular.

In such cases, the following method should be pursued: all the folds of the vulva, the parts covered with hair, and the entire anal region must be scrupulously cleansed with washes of strong carbolic solution; under the spray, a free incision is to be made, as in the case of my first patient; the uterus is to be gently pressed, so that the blood will slowly drain away, and two large tubes are inserted side by side; the gauze dressing should then be applied directly to the vulva, without the intervention of the protective. The mass should be thick, and, at the anus, should make a kind of barrier to divert the intestinal gas. Above the gauze the mackintosh is placed. The dressing needs to be often changed, for, in the first hours, it gets saturated with the fluid and easily becomes infected. It is a good plan to bathe the parts in strong solution at each dressing, but not to make injections. It should be remembered that the skin is more delicate in

some individuals than in others, and, in any event, rubbing with cloths wet in strong carbolized water should be avoided.

Vesico-vaginal fistula and ruptured perineum.

In other operations upon the external genitals we have not the means of sheltering the parts as completely from germs as in the case of occluded vagina. Such are those for vesico-vaginal fistula and ruptured perineum.

Great care should always be taken in the preliminary washings with carbolic water. It is well, before taking the sutures, to touch with the strong solution the surfaces which are to be brought together. There is advantage in employing the antiseptic gauze and protective to afford complete and permanent protection to the wound. Boracic acid lint is very convenient material to form a kind of tampon for the vagina and its neighborhood; but, in all these cases, the antiseptis will be only relative.

Catgut has been a good deal employed both for vesico-vaginal-fistula operations and for perineorrhaphy. In the fistula cases its application is very easy, and we have the immense advantage of not being obliged to withdraw the thread. To make this suture conveniently, we should have catgut which is at once flexible, fine, and solid, as the most of the material in the market is not.

In perineorrhaphy there is no especial advantage in the use of the catgut, except for the stitches which we take in the vagina, where they are absorbed without giving us any concern. Dr. Auguste Reverdin has reported two entirely successful cases, made five days after *accouchement*. He let the stitches take care of themselves. In one of the cases, four catgut sutures were taken in the vagina and five in the perineum. In spite of the most unfavorable circumstances, the union was complete.

The ingenuity of the surgeon ought to inspire him to apply the antiseptic method in these cases in such a manner as not to produce irritation or to injure the sutures.

Enucleation of fibrous tumors of the uterus.

Operations for the removal of fibrous tumors of the womb are rarely followed by serious consequences. It would always be desirable to diminish the chances of peripheral inflammation, and to reduce the more or less fetid discharges which follow the operation.

The method which I recommend and have successfully employed is as follows: the vagina is washed with the weak carbolized solution, or the strong, if it can be borne; after the operation, which is performed in any way the surgeon may prefer, the vagina is again washed out with an abundant injection of the strong solution; then there is placed upon the vulva a large compress, saturated with weak carbolic water, and this should be frequently renewed. Instead of this compress, a generous parcel of antiseptic gauze may be used.

In removing fibrous tumors from the womb, whether they are pediculated or not, I prefer the method of enucleation. I could cite three operations of this kind, in which antiseptic precautions were adopted. The first two were in the service of M. Siredey, and one of the tumors was intra-mural. The vaginal injections were made with the weak solution. Both patients recovered without accident. The third I operated on in this city, with the assistance of Dr. Barborin, of Joinville. The discharge was extremely fetid before the operation. The strong solution was used for the injection, and the dressings were made as I have advised above. The odor disappeared almost immediately, and the recovery was very rapid.

I ought to add that, in all operations which I make at the upper part of the vagina, even simple scarifications of the neck, I use carbolyzed injections. As a complement to these, we may employ antiseptic tampons; but, as they are liable to excite irritation in wounds of the cervix, I usually content myself with vulvar compresses, even after serious operations.

Aseptic accouchement.

If there is any traumatic condition in which asepsis would seem to be more desirable than in any other, it is evidently parturition; and it is plainly a matter of duty to endeavor to afford protection in this state by the antiseptic method. Unfortunately, those who have made the trial seem to have taken into consideration only the infectious element in the development of puerperal accidents; and have not thought of the harm which may come from traumatic injuries and untimely contact. I confess that I have no confidence in constantly repeated vaginal and even uterine injections, or in the antiseptic plugging of the vagina; and I have a particularly poor opinion of injections in the days immediately following delivery.

So, after having made various experiments and seen the very mediocre results of these violent efforts, I have come to the conclusion that, in parturition, the antiseptic surgeon should be satisfied with one thing, and that is absolute surgical cleanliness.

Here are the rules which I have followed for nearly two years in my service in the Cochin Hospital. Not only is every medical officer required to keep his hands clean, but, in addition to this, he is strictly forbidden to make a vaginal examination of a woman, or to pass from one examination to another, without washing his hands in the weak solution.

The only lubricant employed is five- or ten-per-cent. carbolyzed oil. After delivery, the vulva is washed with the weak solution, or, if the case requires, with the strong, and is then dressed with a compress saturated with the weak solution. If the vulva or vagina has suffered any serious injury, the wound is washed with the strong solution. Immediately before operations, the vulva and the surrounding parts are bathed in the same. After serious operations, which have necessitated the introduction of instruments or hands into the vagina or uterus, I generally inject the vagina or even the womb with the two-and-a-half-per-cent. solution, once or several times in succession, taking great care that all the fluid returns. Sometimes I have used the strong solution in such cases.

Last year I performed version in a case of shoulder presentation, occurring in the service of M. Siredey. The fœtus was distended with gas like a balloon, and I practised evisceration. The womb was enormously distended with gas and fetid liquids, and there seemed to be but small chance for the woman's surviving the operation. I rinsed out the uterine cavity with the weak solution several times. The patient recovered without any difficulty.

The question arises as to whether antiseptic precautions can be pushed any further. The spray would seem to have some power in purifying the atmosphere of the ward, but it is not necessary. However, I have used it in wards where I had other patients.

Injections made daily or every other day have been greatly extolled; but, according to my experience, they may be productive of fatal irritation, and I prohibit their employment in my service, except in very rare cases.

Finally, there is a very curious fact. In the great majority of cases the lochia are fetid; but all that is needed to abolish

this odor is to carefully wash the vulva with carbolic water, and to keep its opening constantly covered with a moist, carbolized compress or with antiseptic gauze. Almost invariably it is the contact of the air that makes the lochia offensive — a very interesting fact in its bearing upon the putrefaction of secretions at the natural orifices.

If I have to use tampons, I employ only those that are thoroughly carbolized. I often practise a sort of incomplete plugging after labor, and I have never seen any unfavorable results from it.

The employment of these means has given me excellent results. At the Cochin Hospital in 1878, there were seven hundred and seventy deliveries, serious operations being performed in a good number of them. There were five deaths, of which only two were on account of puerperal diseases, the other three comprising a consumptive, who was admitted in the very last stages, and died twenty-one hours after her *accouchement*; a patient who came from the medical service with acute pericarditis, and lived only four hours; and a woman in convulsions, who expired two hours after entering. Result: not a death from operation; gross mortality, 0.694 per cent.; puerperal mortality, 0.232 per cent.

The most remarkable circumstance about all this is that I had my students examine all the women in labor and all the subjects of operation every morning, and I made them practise the vaginal touch during the operations; and yet the mortality of the patients on whom I operated was lower than that of women in ordinary confinement.

My results in 1879 have not been as good. In the first place, the report is damaged by some cases of women who were brought to the hospital in a moribund condition; but, besides these, there were some deaths which, in my opinion, might have been prevented if the method had been practised with sufficient rigor.

Up to to-day, the twentieth of November, the confinements number six hundred and eighty-five. Eleven deaths have occurred, giving an apparent mortality of 1.60 per cent. But it would be unjust to the hospital to charge the following deaths to its discredit: three women brought in with rupture of the uterus, who were promptly delivered by craniotomy, embryotomy, and the application of the forceps respectively; one woman, dying in eclampsia when she was admitted; and one consumptive, with pulmonary lesions, tuberculous peritonitis, etc., which speedily killed her. In reality, there have been but six deaths due to *accouchement* among the patients who were treated, and this reduces the mortality to 0.89 per cent.

Moreover, in the six there were two vicious insertions of the placenta, cases exceptionally bad in spite of the medium. These women, admitted in wretched condition, exhausted with bleeding, were unable to rally, and rapidly succumbed after delivery.

The actual mortality, therefore, of the institution is four, or 0.58 per cent. — three women delivered naturally and one with instruments.

These two years have presented a considerable number of difficult cases. In 1879 alone there were five vicious insertions of the placenta, cases of eclampsia, and other complications of pregnancy.

The operations performed in these years were as follows: —

Application of the forceps, sixty-two, without a death; besides one in the case of a woman brought in from the city, with a rent in the womb, who died shortly after.

Version, fifteen.

Operation on account of abnormal attachment of the placenta, one; the patient died.

Induced labor, eight; no deaths.

Artificial delivery, eleven; one death from puerperal accidents.

Cephalotripsy, four; no death. In one other case there was evident rupture of the uterus, and the child's head was crushed to facilitate delivery; the patient died two hours afterward.

Embryotomy, one; cured. One other embryotomy was performed to deliver a woman who was dying from rupture of the womb, and who survived the operation but one hour.

Thus, leaving out the artificial deliveries, the mortality from traumatism is really nothing, and consequently less than in the normal confinements; and yet there were ninety-one cases — certainly a respectable number.

In passing, I wish to call attention to the three cases of rupture of the uterus, brought in from the city, and to the case of convulsions, almost dead when admitted. They give us an idea of the numerous ways in which the obstetrical mortality of the city is falsely represented at the expense of the reputation of the hospitals — a subject upon which I shall have something further to say at the proper time and place.

Certainly, we must consider it a fine result to have reduced the puerperal mortality to a point where there are but six deaths in one thousand four hundred and fifty-five cases, or, in other words, about 0.41 per cent. For my part, I declare myself satisfied with this result for a beginning, and for the further reason that I am able to give a large amount of instruction without danger; but I am of opinion that much better results can be obtained. In my service I achieved much less than I sought. A crowd of details still escape me, eluding my vigilance. I have an absolute conviction that, of the three deaths which occurred this year, at least two could have been avoided, although I cannot say precisely in what

respect we were at fault. It is impossible to give the reader in detail all the *desiderata* which I observe. And yet, the attainment of the same results elsewhere requires the absolute reform of the habits of the chiefs of the services, of the administrative officers, and of the students. In lying-in women more than in any other wounded patients is it indispensable to apply the *antiseptic principle* everywhere.

I regret to see large sums of money devoted to the establishment of hospitals which are not really needed. Improvements can be made. With sufficient room and antiseptic cleanliness, the condition of the old and bad institutions can be immensely ameliorated, and it can be made even perfect without any great expenditure in newly invented luxuries. M. Tarnier's pavilion at the Paris Maternity shows how new structures can be built. For my part, I believe in still greater simplicity, and that there are serious inconveniences in rigorous isolation; and I am of opinion that there are many localities which can be made very useful by attending to the following conditions:—

Abolish pure water in the lying-in service, and abandon the use of all germ-bearing epithems; disinfect all the linen with heat, disinfect everything extemporaneously with carbolized water; do not disturb the genitals of the woman, even with antiseptic intent; insure her repose; supply her with sufficient nourishment; keep her quiet at the last of her gestation; exact antisepsis of everybody who comes near the patient.

A thousand useless precautions are taken, and this is neglected. If an *interne* understands sufficiently how to make himself clean, he can devote himself to all his occupations, make the post-mortem examinations which are a part of his duty, dissect, and examine patients without danger. If he is neglectful of antiseptic precautions, it will be best to quaran-

tine him, or else he will always be coming in and poisoning the lying-in patients. The kind who never make a necropsy often kill a great many more people than the anatomists who are careful about antiseptic precautions.

In Paris, all the habits of the students are in need of reform. I do not blame them ; it is physically impossible for them to be surgically neat in the hospital. Reforms are demanded in the interest of the patients and in the interest of instruction, which ought to be made compatible with the safety of the sick. Hardly more than a single word is needed to indicate these reforms. At present, not only is nobody compelled to wash his hands, but it is almost impossible to do it in a hospital, so poor are the facilities.

A liberal and intelligent administration, anxious to comply with the wishes of the surgeons, has made it easy for us now-a-days to practise antiseptic surgery in the hospitals of Paris ; but we do not think the government inclined to favor in every way the practice of antiseptic midwifery.

CHAPTER XXI.

THE LIGATION OF VESSELS. — ARTERIES AND VEINS. — RADICAL CURE OF VARIX. — VARICOCELE.

THE ligation of vessels appears in an entirely new light: there is no elimination of a foreign body, no necessary division of an obliterated vessel, no irritation of the denuded trunk. At the very outset one can see what modifications this involves in our method of treatment.

In the case of ligatures designed to close gaping vessels in a wound, we put in our sutures without any anxiety as to the thread which remains behind. No argument is necessary to prove the immense superiority of this procedure over all that have been proposed to replace the ligature — torsion, forcipressure, acupressure — even if we look merely at the security obtained. So remarkable is the special peculiarity of the carbolyzed catgut that it can maintain itself even in a wound which is not dressed antiseptically, although this is not constant. In my first edition I reported the experience of Keith, who employed it in ovariectomy without the antiseptic method, and of Oliver Pemberton, who used it to ligate the femoral without the Lister dressing.

The ligation of vessels in their continuity, made with all the rigor of antiseptic surgery, may be especially quoted as giving results of the most valuable character. On this point Lister draws his convictions from his experience, which is already very extensive. The wound closes over the knot of catgut, which does not cut the artery. Obliteration of the artery takes place without division. The catgut supports

the vessel, at least in the first days, and until it is absorbed. These facts render it probable that we shall be able to tie successfully the great vessels, whose division so uniformly induces secondary hemorrhage. It is also likely, as certain observations of Lister and his followers seem to show, that an artery, the femoral, for example, may be safely tied close to a large branch. As the artery is not divided, secondary hemorrhage will not ensue.

In this class of operations antiseptic surgery requires nothing more than ordinarily. Nevertheless, it is well to recommend the use of catgut of large size and tested strength. I have seen reports of accidents, which seemed to me to be caused by the poor quality of the material. There is so much bad catgut in the market that I insist upon the importance of this direction. The older the thread is, the better it is.

It has been objected to the catgut ligature that the thread rapidly breaks down, but I have never comprehended the force of the objection. To give way at the moment when the ordinary thread begins to cut the tissues could not seriously be considered as supporting them, and that process begins almost immediately after the application of the ligature.

The catgut divides the inner coats of the artery exactly as the silk does, and repair takes place just as it does when the silk injures the external tunic, that is to say, when the silk does not leave a part of the vessel intact to sustain the inner tunics which have been cut. What does it matter if there is a giving way when the thread is absorbed? After forty-eight hours there is no chance of hemorrhage in the wound. Some experiments upon animals have convinced me of the identity of the mode of repair of vessels.

Nobody at the present time questions the importance of ligation of arteries in their continuity; it has been performed successfully a great many times upon almost all the large

vessels. Of course, it will be understood that the general principles of drainage and of suturing will guide us in the after-treatment of these cases.

The radical cure of varix.

Although formerly we hesitated to apply ligatures to veins, at the present time we can do it with perfect safety, as the thread excites no inflammation, no suppuration around it.

Lister reports a case in which he sutured the lips of a gaping wound of the axillary artery with very fine catgut. It is much simpler and more common to tie the entire vessel. This method has made great progress possible in the surgery of veins. Confident of this, I have employed simple ligation as a means of radically curing varicose veins, making my first operation in the early part of 1876.

The method of procedure is as follows: the large venous trunk is freely, though not extensively, uncovered, and a sufficiently strong thread of catgut is passed under it. A double knot is then tied with moderate tightness, and the ends of the thread cut short. One or two points of silver suture are taken in the skin, a small rubber tube being inserted through an orifice left in the most dependent portion of the wound, which is then dressed in the usual manner.

This operation has suggested itself to several surgeons. Schede performed it after me, adding the division of the vein between two ligatures. Risel, of Halle, tied in two places, and excised the intervening portion of the vessel. Annandale published in 1879 the report of a case in which he removed from the left leg of a young man an enormous mass of varicose veins, measuring forty centimeters in length, twenty-five in breadth, and fifteen in height. His patient made a perfect recovery, and was still well four months afterwards.

This excision may be treated with drainage or with complete closure, according to the extent and situation of the wound.

Annandale has practised ligation of veins for a long time. He reported a case of varicocele treated in this way as early as 1874.

This new application of old methods, now revived with modern security, can be utilized in a great many cases, by following out the general indications.

CHAPTER XXII.

THE TREATMENT OF ABSCESSSES.

Acute abscesses.

THE treatment of abscess is certainly one of the most curious applications of the Lister method, for it is very remarkable to see the cavity of an abscess, even though it be very large, stop suppurating the moment it is opened, and close, as one may say, by first intention, so rapidly does the adhesion of its walls take place.

The openings into an acute abscess need not be nearly as extensive as by the ordinary method; but, if the patient is anæsthetized, I prefer a large incision, which I afterwards reduce by taking two or three stitches.

After the evacuation of the pus, it is useless to make an injection, if the cavity is small; but if it is very large, it is necessary to throw into the cavity some carbolized water, strong or weak, according to the region involved, and to cleanse it very carefully. Then the stitches are taken, one or two drains put in upright, and the dressing is applied in such a way as to moderately compress the walls of the cavity. If the discharge is abundant, the protective is useless.

The suppression of the purulent discharge, which is followed by one of a sero-purulent character, is a surprise at the first; but the rapidity of the healing is much more astonishing.

I have now practised this procedure more times than I can enumerate; but I can cite some large abscesses which have

healed up with amazing speed. I cured in this way, in exactly eight days, a huge abscess in the sheath of the right carotid of a young man. In the service of M. Millard, at Beaujon, two years ago, I opened a large perinephritic abscess in a young woman. It was a phlegmon, with its point of departure in a uterine lesion, the causation of which I made out by the assistance of my researches upon the lymphatics of the womb. This patient, confided to the care of Dr. Tapret, then the *interne* on duty, was cured in eight days and with three dressings. At the Lariboisière I opened by a simple puncture an enormous abscess in the axilla of a young man, and ten days after there was not a trace of suppuration.

When abscesses are small, the cure is effected much more rapidly, and in regions where the scars are not covered by the clothing, this is a very important fact. In regions like the breast, where the abscess is the point from which new inflammations push out in every direction, we are much less likely to have a series of abscesses. The secondary purulent sinuses disappear. Cicatrices on the borders of great abscesses no longer come to weaken people whom, otherwise, months of suppuration condemn to suffer permanent retractions.

This result is particularly noticeable in whitlows and phlegmons in the palm of the hand. In these cases it is well, after having freely opened the abscess, to wash it thoroughly with the strong solution. As the parts have generally been covered previously with cataplasms, it is necessary to take extraordinary care in the bathing which precedes the operation.

The same remarks will apply to the treatment of anthrax. As regards the pain, for the relief of which it is usual to recommend the heat of a cataplasm, a hypodermic dose of morphine will soothe it more completely and constitute a desirable substitute for the common epithem.

Finally, I insist upon this fact: it may be useful, after the incision is made, to inject the cavity in order to completely empty it of pus; but this should by no means be repeated afterwards, as it will retard the healing process.

In some cases, where the pouch is infected anteriorly, where it has been impossible to maintain the aseptic condition, copious washings of the cavity with carbolyzed water are required. The necessity of thoroughly evacuating the injected fluid must never be forgotten. It is almost always in cases of large pelvic or perirectal abscesses that poisoning occurs. I have seen a pelvic abscess the injection of which gave rise to slight toxic symptoms. There was need of a counter-opening, which being made, the injections were continued without further difficulty.

Where there is intolerance of carbolic acid, a weak solution of chloride of zinc is of great service.

Cold abscesses.

In these, the modification in the walls requires to be more complete, and it is well either to inject the cavity with an eight-per-cent. solution of chloride of zinc, or to scrape the inner surface with the curette of Volkmann. I have had good success with both methods.

Congestive abscesses.

The treatment of these is certainly one of the most difficult applications of the antiseptic method, but it is also one of the most valuable. Up to the present time they have been *noli me tangere*, and the surgeon has approached them only with extreme repugnance.

If they are opened antiseptically the first result is that the

evacuation of the fluid is not followed by inflammation of the pouch. A serous matter continues to be discharged. If the dressing is kept on a long time, the cavity is finally reduced to a narrow fistula, and the primary lesion, after elimination of the sequestra, may heal spontaneously. The opening should be sufficient for very easy drainage and for the passage of a tube. In cases of migratory abscesses which have started from a distant point, as the vertebral column, it is better to simply open them without washing them out. Where the original seat is less remote, and the pouch is but moderately large, the injection of carbolized water on the first day may be advantageous. Lister quite generally puts in a horsehair drain in these cases.

As the treatment is long, it is necessary to carefully avoid making the opening in the neighborhood of any source of putrefaction, such as any open suppuration or a natural cavity. If this condition cannot be fulfilled, it will be wiser to defer the opening a while.

The result of the operation in this class of cases is that the cavity is reduced in size and the walls to some extent adhere to each other. If the abscess depends upon extensive bony lesions, the sequestra will be thrown off, and the healing will take place slowly, without fever, without any surgical complication. When the osseous disease is accessible, the incision of the abscess will, of course, be followed by the operation which is necessary for a cure. If the involvement is only superficial or periosteal, affairs progress more rapidly.

The treatment of these abscesses requires extreme exactness in the application of the dressing; for, if there is any lapse, the healing will be retarded not a little, and often the termination may be fatal, as in cases where the abscess is opened without the precautions. These recommendations are all the more necessary, as the treatment may be extremely pro-

tracted. This is one of the cases in which it is especially desirable to complete the dressing at its periphery with salicylic wadding or boracic-acid lint, so as to effectually prevent the entrance of air.

Finally, I have had occasion in some large abscesses to make injections of a ten-per-cent. solution of chloride of zinc. I have made this addition to the method when I was not sure of the quality of the dressing and of the antiseptic precautions. In the case of a young man who had an immense abscess in the dorso-lumbar region, I made two of these injections. After the second, he had a pleurisy, with which the injection was certainly not unconnected. He got over his pleurisy very well, and in the mean time the purulent cavity perfectly closed, and did not re-open in the ten months during which I kept him under observation.

CHAPTER XXIII.

EMPHYEMA. — HYPOGASTRIC LITHOTOMY.

ONE would expect the operation for empyema to give exactly the same results as the opening of abscesses in general, and yet it is undeniable that often the dressing is insufficient to prevent the infection of the cavity. More than ordinary precautions are necessary, as is well shown in a case reported by John Duncan in 1878, where the insufficiency of the antiseptic atmosphere was perfectly evident.

I think that, in many cases, one may dispense with injections of the cavity, at least for a long time, and yet he is generally led to make them. My advice in such cases is to distrust carbolic solutions, which are very rapidly absorbed by the pleura, and to use instead injections of boracic-acid water or even a weak solution of chloride of zinc.

Hypogastric lithotomy.

Many authors have thought supra-pubic lithotomy preferable to the perineal operation, and it seems as if the antiseptic method was destined to dissipate the objections made to the former. The facts are not yet sufficiently numerous for us to judge; they are almost all derived from cases in infants, who, on account of their tender years, present a condition peculiarly favorable for hypogastric lithotomy; and yet it is clear that this is the direction in which progress is going to be made.

In his thesis in 1873 Zayas Bazan described an operation which he saw Professor Lister make upon a boy of fourteen years. The peritoneum was opened, and then closed with a suture. The bladder was sewed up, then the abdominal wall, and a drain was inserted under this suture. The recovery was rapid.

In an article in *Hygiea*, in 1878, Carl Rossander made a long plea for epicystotomy. In the last congress at Amsterdam, Dr. Van Goudaever, of Utrecht, read an interesting article, in which he recommended supra-pubic lithotomy in all infantile and many adult cases.

While, in perineal lithotomy, it is almost impossible to make use of the precautions of the antiseptic method, it is entirely practicable in the supra-pubic operation.

All the steps of the operation are the same. Nearly all authors advise complete suture of the vesical walls with cat-gut. The suture of the abdominal walls should be incomplete, an opening being left at the lowest portion for the introduction of one or two drains. The dressing around the penis ought to be made with great care. Lister thinks it desirable to complete it with boracic lint, making a sort of sheath for the organ. According to most authorities, it is better to practise catheterism than to let an instrument remain all the time in the bladder.

CHAPTER XXIV.

CASTRATION AND OPERATIONS UPON THE TESTICLES.—CURE OF HYDROCELE BY VOLKMANN'S METHOD.

OPERATIONS upon the scrotum require peculiar precaution on account of the mobility of the parts, which necessitates the application of a generous quantity of wadding around the ordinary gauze dressing. The conformation of the region, also, and the character of the skin call for much more care in washing than any other parts. However, we should avoid letting strong solutions of carbolic acid remain too long in contact with the penis, lest severe irritation be produced.

Castration.

The use of the catgut ligature makes this operation very simple. It may be done in two ways, either by tying the cord in a mass, or by dividing it into two or three portions and ligating each separately. It has been proposed to isolate the vessels and tie each by itself; but this involves unnecessary trouble.

The catgut does not separate, and the extremity of the cord is not thrown off. The wound is closed like any other, a drain being introduced at the most dependent part, and withdrawn after a few days.

I removed a very large sarcomatous testicle from a patient a while ago, and, in seventeen days, the only trace of the operation was a linear scar.

The decortication or simple opening of hæmatoceles may be

effected by a similar procedure, without subjecting the patient to any appreciable risk.

Hydrocele.

It is well known that, for some years, Volkmann has practised simple incision in treating hydrocele, following with the suture of the tunica vaginalis. Sometimes a drainage tube is employed, and sometimes not ; but the former method is the more prudent. There are no phenomena of inflammation and no suppuration. The time required for the cure is rather less than after the injection of iodine, ten or twelve days, and no ill consequences have been observed.

CHAPTER XXV.

OPERATIONS ON TENDONS AND THEIR SHEATHS. — THE OPENING OF LARGE CYSTS. — CLUB-FOOT. — THE SUTURE OF TENDONS.

THE opening of the sheaths of tendons causes suppuration no more than the opening of the peritoneum or the articulations. It may be done in many different ways. The opening of large compound ganglia of the wrist, formerly so greatly dreaded, has become almost common. The cyst is thoroughly emptied, and closed up with sutures, and the patient quickly recovers.

Club-foot.

The subcutaneous method of operating on tendons entirely loses its importance in the presence of Listerism, and nothing is easier than operating with everything exposed to view, as it can be whenever any difficulty arises. There are plenty of cases already on record in which the division of tendons has been followed by immediate union.

The suture of tendons.

This operation, formerly performed frequently, is now done with catgut in much more favorable conditions. It has already been made so many times in different circumstances that it is quite superfluous to cite cases. The rules for the application of catgut are the same as those to be followed in using silver wire, only that no provision is required for the cutting of the stitches.

CHAPTER XXVI.

TREPHINING THE SKULL.

IN a monograph on trephining by the antiseptic method, I have given my reasons for considering this operation no longer grave, but one which may be made without apprehension. It has now been performed a good many times by the Lister method. The only things about it which require especial mention are the desirability of careful drainage, as always in large wounds of the head, and the necessity of a scrupulous preparation of the surrounding parts, on account of the difficulty of freeing the scalp of greasy matters which pollute it.

In a case of hemorrhage of the superior longitudinal sinus, Professor Lister carefully plugged the entire cavity in the skull with catgut. The bleeding was arrested, and there was no impediment to recovery.

CHAPTER XXVII.

THE TREATMENT OF ULCERS. — EPIDERMIC GRAFTING.

EPIDERMIC grafting, as practised by my colleague, Dr. Jacques Reverdin, is greatly facilitated by the Lister method, indeed, just in proportion to the extent to which we render the ulcers aseptic and, consequently, favorable soil for the growth of the grafts. If the ulcer is not of very long standing, after it and its immediate neighborhood have been carefully bathed in carbolized water, it will be sufficient to wash its surface with an eight-per-cent. solution of chloride of zinc. It is then covered with a large protective, and a dressing of boracic acid is applied. After two or three days, we cleanse the ulcer with a boracic solution, and proceed to the grafting.

If the granulations on the ulcer are well formed, there is an advantage, before applying the zinc, in cleaning the surface with Volkmann's curette, for the purpose of removing all exuberant growths, and then washing, and letting the wound rest for a few days under the protective and a boracic dressing, the latter being renewed daily. We wait some days that we may not be impeded by the bleeding, and then proceed to graft in the following manner, described in a note which Dr. Reverdin has been so kind as to write me.

The almost absolute certainty of obtaining immediate union and the simplicity of the progress of wounds under the Lister dressing ought to induce all surgeons to employ it in epidermic grafting and in transplantations, both dermo-epidermic and dermic. Lister himself, in a lesson upon the boracic acid

dressing, devotes to the subject several pages, of which I present a *résumé*. The skin on the inner aspect of the fore-arm is cleansed with the strong solution of carbolic acid. Then a little piece of it, including hardly more than the epidermis, is removed, and being placed upon the thumb-nail, moistened with a drop of boracic solution, is cut up into minute fragments of the size of the head of a pin. These bits are, one at a time, placed upon the granular surface of the ulcer, which has been, up to this point in the procedure, carefully covered with a piece of muslin soaked in boracic solution. Now only as much is uncovered at a time as is necessary for the depositing of each graft; and, as fast as this is done, the part is immediately covered again with a little piece of protective which has been dipped in a boracic solution. The operation being completed, a large protective is spread over the entire surface, over this the boracic lint, and the whole is secured by a bandage. This dressing is allowed to remain for two or three days, and is then removed. One must content himself with cleansing the surroundings of the ulcer, and avoid touching the granulations themselves, lest he destroy the adhesions which the grafts have contracted. Very soon an epidermic zone will be seen developing around each of the grafts; and the same dressing is continued until the breach of surface is entirely closed. The insignificant wound of the fore-arm is at the same time dressed with protective and boracic lint.

In some cases, Lister substitutes for the lint a piece of cloth spread with boracic acid salve; but every graft must be shielded from contact with this preparation by a bit of protective.

It is probable that many surgeons have used the boracic or carbolic dressing in grafting. Reverdin has employed the antiseptic method in such cases a number of times with conspicuous success.

Volkman, of Halle, also has used the antiseptic method in these cases. He generally takes large grafts and places them side by side, so as to cover the whole surface as with a mosaic. This, however, would hardly be accomplished in surfaces of any great extent, except in a hospital, where the integuments of recently amputated limbs can be utilized.

Schede, of Berlin, proceeds thus : the ulcer is scraped with a Volkmann spoon, so as to obtain a bloody surface entirely freed from dirt ; strong disinfectants are applied ; then dermo-epidermic or dermic flaps of some size are put in position, side by side, like a mosaic ; and the antiseptic dressing is put on. The success is generally complete, the ulcer being closed in a few days. Schede applies the dressing in the following manner : the grafts being in place, he takes a large bandage of antiseptic gauze, spreads it over the wound, and presses it down, thus squeezing out the blood, which, passing through the meshes of the gauze, is stanchcd ; then he rolls the bandage around the limb, and covers it in with the Lister dressing, omitting the protective.

It will be seen from what precedes that there are several methods of grafting. By strict attention to these directions, we are sure to obtain results far superior to those formerly observed.

CHAPTER XXVIII.

OPHTHALMIC SURGERY.

THE Lister method has been employed in ophthalmic surgery, and with a certain measure of success; but the question of the best antiseptic has somewhat impeded its progress. In most cases, indeed, the eye will not endure an irritant, antiseptic, and so recourse to boracic acid has been advised, or, after having taken all the antiseptic precautions, the employment only of topics which are aseptic and imputrescible, like vaseline, but not really antiseptic, in the proper acceptance of the term.

But carbolic acid has been employed; and Dr. Rossander, of Stockholm, published in 1878 and 1879 the results of his operations. He washes the patient's face, and his own hands and instruments in carbolic water, and uses the spray in cataract operations, dressing with antiseptic gauze. In this way he made twenty-seven cataract operations without a case of suppuration either of the cornea or of the entire eye. Up to that time nothing like this result had been seen in that hospital.

At the last congress at Amsterdam, Snellen read an important paper which proved the utility of the following proceeding: the preliminary washing of the field of operation and of everything which is to touch it in one-per-cent. carbolic water, and the cleansing of the instruments in alcohol, should be observed in any operation upon the cornea. In such cases, the use of the spray presents decided difficulties,

and is successfully replaced by a current of air purified with carbolic acid. For an antiseptic and occluding dressing, it suffices to employ pieces of cloth saturated with vaseline and bits of purified cotton. Irritant antiseptic preparations, which augment the secretion of the conjunctiva and palpebral glands, ought not to be used.

In an interesting article in his ophthalmological review (November, 1879), Galezowski shows how he has put in practice the principles of the method. In a general way, he employs as an antiseptic a one-tenth-of-one-per-cent. solution of carbolic acid. The eye-washes are more frequently made with boracic acid. In addition to these, he uses only pieces of dressing previously disinfected. These precautions have already given excellent results. All these precepts are good; and yet the method can be much more closely followed. In the first place, all the general precautionary measures, relating to the surroundings of the patient, the washing of instruments, hands, etc., should be taken just as for other operations, with the strong solution.

Operations involving the transparent media will not permit free washing with carbolic acid, but a boracic solution, even the concentrated, is perfectly well borne. The spray may be used, provided the spray-producer is sufficiently removed, and a weaker solution than usual employed.

Only that dressing will be antiseptic which effects occlusion, and, for this purpose, the only substance which is entirely unobjectionable is the boracic lint. I have used it in this way, and, for these cases, I prefer it to the carbolized gauze. According to circumstances I use it dry, or saturated with an aqueous solution of boracic acid.

Operations upon the conjunctiva require about the same precautions against the irritant action of a powerful antiseptic. But if the eye is destroyed, as in enucleation, or if the

operation is outside of the eye, for example, autoplasty, the carbolic acid resumes its place in our esteem. Nevertheless, I advise its employment in connection with that of boracic acid. For example, in enucleation I freely wash the cavity of the orbit with the strong solution, and then dress with boracic lint. I used to put under the lid the classic wad, making it of boracic lint; but now, I think it much better to do nothing of the kind, and simply place a boracic dressing outside, keeping it there until cicatrization is perfect, which is usually but a short time.

For little wounds about the lids, I recommend the employment of boracic ointment spread on fine cloth, putting over it either a mackintosh or a layer of boracic lint, according as a wet or dry dressing is desired.

It will be seen that, by following these directions, the application of the antiseptic method in ophthalmic surgery is possible and even easy. It will be noticed, indeed, that here we are not menaced with great quantities of fluids putrefying upon the dressing, and so our antisepsis is continually fresh. But it must not be forgotten that it is almost impossible to absolutely purify the sulci of the conjunctiva. Boracic acid and vaseline are the best agents to employ either singly or together.

We all know how desirable the entire absence of supuration is in ophthalmic surgery, and understand that the attainment of this end ought to be sought with unremitting zeal.

CHAPTER XXIX.

INFLUENCE OF LISTERISM UPON THE HEALTHFULNESS OF HOSPITALS.

ONE of the chief advantages of the method is its favorable influence upon the salubrity of hospitals. All the operations which I have mentioned were performed in hospitals with absolute safety. It was in a hospital that Lister made his great demonstrations of his method ; and in the wards of a hospital I myself have opened joints and serous cavities, and dissected veins, without any fear of accident or contamination from the media.

Every wound is instantly shut up in an antiseptic atmosphere, which is probably even purer and more healthful than mountain air. Of course, this is no reason for neglecting hygienic rules and seeking for bad hospitals, for it is always wiser to have as few and as insignificant foes to contend with as possible ; but it is a reason for defying infected media, if need be, and for using existing hospitals with proper precautions.

If the method is constantly employed, it exercises a beneficent influence upon the general salubriousness of the service. The action of perpetual emanations of carbolic acid is obviously favorable. Soon everything becomes impregnated with it ; even the drain-pipes at last cease to emit any putrid odor. This was the experience in my own service, where all possible pains had never succeeded in disinfecting a certain sink in the obstetric ward ; but now that we are constantly throwing carbolized water into it, the odor

has entirely disappeared without any one's troubling himself about it.

I have such confidence in the efficacy of these means that I am perfectly convinced that, by combining thorough carbolic pulverization and washes, we might clearly rid of their baneful influences the lurking-places of epidemics. To establish the correctness of this view would require a far greater number of facts than I can contribute; and yet I have had experience in rooms where patients have sickened and died of puerperal fever, erysipelas, and other such diseases, and, after I had employed the spray and washings, no evidences of contagion appeared. This limited observation of mine is inconclusive, but it is in a direction in which it is worth while for others to follow.

The spray is a valuable method of impregnating anything you please; and, by using it in connection with the purification of cloths and garments, by means of superheated air, we are destined to attain results the entire importance of which nobody can foresee.

If the antiseptic method makes hospitals healthy for the present, it makes them so for the future. Whoever desires to profit by all the results of the method should make its application as extensive and as general as possible; and day by day he will find his work made easier by the progressive purification of the media in which he performs his operations.

Finally, let us not lose sight of the fact that the method is of advantage to the surgeon and his assistants in greatly diminishing their chances of meeting with accidents. This comes from their living in a purified atmosphere and having their fingers constantly impregnated with the substance which is most powerful in neutralizing every kind of septic matter. I am aware that this suggestion may not be considered chiv-

alrous, and sometimes one would decline to entertain it; and yet it seems to me to be important, for our assistants pay a cruel tribute to wound complications by the lesions which they contract in the wards; and I am thoroughly convinced that, with the antiseptic system, this heavy burden will be lightened.

CHAPTER XXX.

CARBOLIC ACID POISONING. — CARBOLIC ECZEMA.

A GREAT cry has been raised about the toxic properties of carbolic acid, and its speedy condemnation has been predicted, although positive facts on the subject are so extremely rare that it is even now impossible to study it with any great satisfaction. Kuster has investigated it more carefully than anybody else, and Nussbaum, in the second edition of his book upon the antiseptic dressing, has an excellent chapter on the subject.

Undoubtedly carbolic acid is toxic; physiologists have shown upon animals that it acts like a poison. And yet it is employed in enormous doses upon human beings without accidents or annoyance. The discoloration of the urine, which turns green and black, headache, and sometimes gastralgia, are the most common phenomena of the toxic state produced by it. In some cases, which are infinitely infrequent, sudden collapse has been observed, a kind of sideration, with loss of consciousness, small pulse, and cold surface. A few of these cases have terminated fatally, but the most have recovered.

Some individuals evidently have a peculiar susceptibility to the acid, of which I have seen some remarkable illustrations. Poisoning may undoubtedly occur from the injection of absorbent cavities from which the return of the liquid has not been provided for. It is very curious that, in the hands of those who have practised antiseptic surgery most — Lis-

ter, Volkmann, Saxtorph, and myself — nothing like this has ever occurred. Nussbaum, who has reported a remarkable case, points out how accidents may be avoided in these cases.

Cases in which strong solutions have been injected into the areolar tissue around the rectum have proved fatal. I have seen patients with abscess of the iliac fossa and with empyema display transitory phenomena of poisoning, which, however, were easily dissipated.

Prudence should be exercised in certain regions, and we ought probably to take into account some cachectic states; but especially is age a matter of moment. Very young children are singularly susceptible to the action of carbolic acid.

For a long time I have thought that erythema of the buttocks, so common among new-born infants who are attacked with diarrhoea, was probably parasitic and amenable to carbolic acid. One day last year, finding some babies in this condition in my service at the Cochin Hospital, I ordered a dressing consisting of a bit of fine cloth saturated with ten-per-cent. carbolized oil. The effect was excellent and speedy; the nurses in charge of the children were amazed, and, instead of following my directions, that evening they conceived the unhappy thought of completely enveloping the lower limbs and bodies of four little unfortunate wretches in a large compress soaked in carbolized oil. At my visit next day I found these babes with pinched features and cold skins, vomiting, and with diapers stained black by the urine. The discovery of the unfortunate dressing readily explained their condition. Two of them died; the other two slowly recovered, and, strangely enough, were completely relieved of their erythema.

I have continued to treat cases of this kind with carbolized

oil, taking care to repress so excessive a display of zeal in the nurses, and no other accident has ever occurred. I mention the occurrence to show how very rapid the absorption of the acid may be in very young children, and that, notwithstanding this, it may be used with proper precautions.

We must always remember that, like all other active agents, carbolic acid has certain undesirable properties, for which we must be constantly on our guard.

In cases where we are obliged to leave injected fluids in an absorbent cavity, we must avoid the employment of strong solutions, or even substitute chloride of zinc for carbolic acid. When, in patients with wounds, the urine continues black, nausea arises, and gastralgia and headache persist, we must either lessen the doses or discontinue the use of the acid.

But we should neither dispense with this powerful agent, nor make such assertions about its dangerous properties as is done in a report in the *Centralblatt f. med. Wissenschaften* (7th September, 1878), in which it is related that poisoning occurred on account of a utero-vaginal injection, the liquid having passed into the peritoneum.

The most perilous region as regards the action of carbolic acid is the perirectal, the most of the serious cases having been, as was previously remarked, those in which injections were made into the areolar tissue of this locality.

It would be well, also, to avoid the excess in employing carbolic acid in which certain imitators of Lister indulge, offsetting their lack of precision in the observance of his directions by an extraordinary misuse of the antiseptic. After having observed these modes of operating, one cannot escape the conviction that the danger in using carbolic acid is extremely small, for no harm comes from this unwarrantably lavish employment of it. But that is no good reason for following such an example.

There is one other point which it is necessary to take into account — the quality of the acid. In France, our acid, even the crystallized, is very bad smelling, and contains some toxic impurities; but I have every reason for believing that, if a perfectly pure article is used, such as may be obtained from certain drug establishments which purify it themselves, the chances of accident are infinitely reduced.

Theoretically, the sulphate of sodium is admitted to be the antidote to carbolic acid, and, in case of poisoning, Nussbaum recommends the following prescription:—

Sulphate of sodium	5 grams.
Distilled water	150 “
Syrup of raspberries	25 “

Of this two spoonfuls are to be taken every two hours. In cases of profound collapse, he especially advises artificial respiration.

Carbolic eczema.

Most cases of this affection result from holding the spray-producer too near the part operated upon. Cases in which the skin cannot endure carbolic acid at all are very rare. I have reported the case of a young man one of whose toes I amputated. He had so severe an eczema on the dorsum of his foot that I was forced to use the boracic acid instead. In fact, boracic acid is our best resource when we require an antiseptic which is entirely free from irritating properties.

CHAPTER XXXI.

OBJECTIONS TO THE ANTISEPTIC METHOD.

THE great success of Listerism, its achievements, so almost incredible from the point of view of received ideas, its practice, so profoundly modifying the common course of surgery, naturally aroused lively antagonism. Antiseptic surgery was scarcely invented before violent war was made on it, from which the amenities of science were to a large extent excluded. From the very beginning, Lister's invention was disputed. In a curious article (*Lancet*, 1867) the illustrious Simpson attributes this discovery to all surgeons successively, at the same time declaring the method to be absurd and bad. Since then there has been written no diatribe which is either better or worse.

When Lister had succeeded in proving that he claimed neither the discovery of carbolic acid nor the surgical employment of antiseptics, but an *ensemble* of measures for antiseptic protection, for the defence of the organism by definite means, then discussion was directed to the principles, the nature, and the mode of action of the dressing.

It was alleged that there was nothing new in it; it was only a variety of dressings by occlusion. It is sufficient, however, to have seen the dressing but once, or to have attentively read a description of it, to become convinced that it is not an occlusion dressing.

Others, better informed, recognized in it a variety of infrequent dressing, and generally went back to the celebrated descriptions of Magatus in 1616. But the dressing is infre-

quent only to those who do not know how to apply it. Indeed, it is necessary to renew it very soon after the operation, and one can rarely avoid a renewal within the first twenty-four hours. After this, the dressings become infrequent only in proportion to the length of time which has elapsed since the operation. Are not these indications exactly opposite to those of the infrequent dressing?

Others still have argued, *a priori*, that the dressing could be of no use, because the micro-organisms counted for nothing in the causation of accidents; that putrefaction is accomplished independently of them; and that, at most, they are but a product. It is even added, as a general thing, that the wounds which have putrefied the most are most exempt from accidents.

I shall not discuss this argument here. It is perfectly certain that the more perfect the defence against germs is, the better are the results of surgical operations. Under the Lister dressings, the micro-organisms are very rare and of a low grade of vitality.

Not only do we not deny that wounds heal even though they be infested with micro-organisms, but we believe that the explanation of the fact is to be found in the power of resistance possessed by the healthy tissues and in the variety of the organisms, some destroying others.

But if all this carried no conviction, if the theory were utterly false, the practice remains, and some other explanation of its results must be sought. A chemical theory might be advanced, but there are no facts to support it. Under the influence of well-applied antiseptic protections, the repair of wounds is metamorphosed.

As far as the putridity of wounds is concerned, there are, indeed, surgeons who do not take pains enough to avoid it, but there is none who goes so far as to seek for it for the

sake of putting himself in accord with pretended scientific theories.

Still others think that the general condition determines the fate of the patient who undergoes an operation: that he will recover if this is good, will die if it is bad. But the surgeons who are most resolutely antiseptic in their ideas do not question the large part played by the precedent condition of the organism; in their opinion, even, that which proves the excellence of the method is that the influence of the state of the system loses a great deal of its importance, as repair becomes so easy, and we dare to operate upon patients whose general condition would, but for Listerism, make us hesitate. An eminent master, who for a long time has devoted great attention to the influence of constitutional states, Professor Verneuil, emphatically expresses this opinion.

Some other authors have been willing to admit that the method possesses some virtue, but this they ascribe to its antagonism to contagion, although Lister has not thought of this contagion. One must be very little acquainted with the surgeon and very ignorant of his method to advance this argument. It will suffice to have read my description to see that his object is to avoid something very different from contagion.

More direct objections to the practice have been made, which constitute, in the minds of some authors, insurmountable obstacles to its progress. Those who have made these criticisms have a poor understanding of the method — sometimes none at all.

It has been especially alleged that it seriously complicates the operations. A good spray-producer does not interfere in any way, and it would be childish to consider the other precautions as impediments.

It is asserted that the dressing is difficult, tedious, necessi-

tating the presence and assistance of the chief of the service, that it is distressing and painful to the patient. As far as all this is concerned, I can say that I have never yet seen a good *interne* who did not apply the dressing rapidly and well; and this is the more to be expected, as the dressings are strikingly similar in all cases. As there are fewer of them to make, it is perfectly plain that, in the long run, a patient requires much less time and attention than if he were dressed by any other method.

The dressings are not painful, because they are not unclean, because they do not torment the wounds by frictions and bathings, and especially because they do not excite any inflammatory action. And, furthermore, carbolic acid does not cause pain, as alcohol does, for example. Far from this, we know that it actually has anæsthetic power. Above all, with the spray, we can perform operations which are not very painful upon infants without anæsthetizing them. I have, indeed, made several operations without using chloroform, and the patients have evidently suffered very little. At the Saint Louis Hospital, Laitler is at the present time employing the carbolic spray to produce anæsthesia of the skin in cases of violent pruritus. He was led to pursue this course by the remarks made by several of us at the Surgical Society upon the anæsthetic property of carbolic acid.

Great objection has been made to the dressing on account of its costliness — a consideration of some importance in hospital service. I am prepared to assert that this is a remarkable exaggeration, and I have good reason for knowing, as, during the first six months, I dressed at my own expense all the patients on whom I operated. I privately imported from Edinburgh all the materials, when, too, they were very high-priced. I found the expense of the pieces necessary for the seven dressings, after an amputation of the leg at the upper

third, to be about two dollars and forty cents. This patient was healed in twenty-four days, and was able to leave the hospital on the thirtieth. In Nussbaum's excellent work I find an estimate of the pieces of dressing which he considers necessary in a thigh amputation, and, reckoning on the same basis, fifteen dressings would cost about five dollars. Since that time the price of the materials has been greatly reduced, so that, if one does not waste the pieces, as I have often seen done, the dressing is, in reality, quite inexpensive, far more economical, indeed, than most of the dressings employed to-day in hospitals, where alcohol almost always plays an important rôle.

It may be added that the patients do not suffer, have no fever, enjoy their food, require no costly medicines, and have no need of especial attentions. But, above all, the rapidity of healing is extraordinary; and, were its only advantage the abridgment of the patient's stay in the hospital, the method would be a great piece of economy. In his very remarkable book upon antiseptic surgery, Nussbaum shows that the subjects of amputation, by the shortening of their sojourn, cost, at the rate of fifty cents a day, from seventy-five to one hundred dollars less than formerly. It is easy to see that a great saving is made in the Paris hospitals, also, where the cost per diem is about fifty-three cents a patient. Each dressing at the highest price costs only from twenty to thirty-five cents, and the abbreviation of the stay in the hospital varies between fifteen days and three months. The objectors to the method say that carbolic acid is irritant, and insupportable to the patient and the surgeon—an argument reproduced within a month at the Surgical Society. It is necessary, to start with, to have a clear understanding as to this word "irritant." If they mean that carbolic acid is caustic, and that it attacks the epidermis of the operator, thus making it

a little disagreeable for him at times, the statement is true ; but, if they mean that the acid irritates the wounds, that it excites inflammatory complications, it is false, at least in the case of any man who knows how to use it. Indeed, it is strictly forbidden to let the carbolic acid remain in contact with the wounds, with tissues in the course of repair ; but its temporary contact with a wound causes no irritation. Like all other disciples of Lister, I have washed with it the most sensitive tissues — the peritoneum, the synovial membrane of the knee-joint, the tissues of the orbit, the dura mater — and I have never seen any of the phenomena of irritation. If any one does see them, it is because he has failed to follow the precepts which I have laid down.

The dressing has been accused of favoring hemorrhage, and Demarquay has been particularly strenuous upon this point. The value of his observations is indisputable ; but as he has evidently fallen into an error here, I dwell a moment upon this point. It is true that carbolic acid is not hemostatic, and irrigation during an operation may rather favor the discharge of blood than check it ; but, for my part, I see no harm in that, for I am not averse to leaving in the wound as many ligatures as may be necessary to check this bleeding, tying veins as well as arteries. If secondary hemorrhage comes on, the operator must take the blame of it. Once I had such a case, in which profuse bleeding occurred after eight hours, entirely due to the fact that I had neglected the ligature of an important artery. Furthermore, we should remember that the majority of operations upon the extremities at present are made with the application of the Esmarch bandage, or, at least, with a rubber ring around the upper part of the limb. This method, too generally adopted, is the great cause of secondary hemorrhages, and I have long believed that the Esmarch bandage is far from being indispens-

able, except in a few cases, such especially as the search for a divided vessel, and the destruction of diseased portions of bone. A better means is needed, by which we can make less compression and produce less paralysis. The modification designed by my colleague, Dr. Nicaise, gives, in this respect, very satisfactory results.

When the blood is well stanchd, even if a little oozing still continues, the dressing may nevertheless be applied, light compression being employed. The discharge soon ceases, and the blood which escapes under the flaps does not hinder union.

Other objections are of more importance. The odor of carbolic acid is disagreeable to some patients; but I have rarely heard any serious complaint.

The odor is more distasteful to the surgeon, because it impregnates his hands and his garments. If the acid is of good quality, this odor is less penetrating, and one may lessen its effects by various means. I am convinced that some other substance will be discovered equally good for washing the hands.

Carbolic acid is sometimes irritant to the skin, and, in such a case, that which is of poor quality should be thrown away. Very rarely it awakens under the dressing a sort of eczema in people who are especially susceptible. The substitution of boracic acid easily remedies this difficulty. This irritation is more seriously disagreeable for the surgeon's fingers, which, being often wet with the strong solution, become harsh and rough, and are also the seat of annoying prickling. By taking care, this inconvenience may be partially avoided. To me, these are the only serious objections to the method, and I certainly do not find them sufficient to induce me to throw it aside.

With still more reason do I find myself completely insen-

sible to the objection of those who consider these surgical complexities inadmissible, who think that all surgery may be done with a bistouri and a bit of charpie, provided there is a stream of water in the neighborhood. This does not prevent them from planning hospitals which cost millions, and inventing cunningly devised instruments, which are very expensive for a single patient ; and, besides, they do not neglect to comfort their patients with costly medicines, provided that all this does not deviate too much from approved usages. Then, after all, the patients who have been operated on with the bistouri and bit of charpie, in the hospital or even in the city, will have first to escape the actual dangers to which they are exposed, and then, in the most favorable circumstances, will be obliged to devote two or three months to the cicatrization of a wound which ought to be healed in fifteen days or three weeks.

CHAPTER XXXII.

THE EMPLOYMENT OF VARIOUS MEANS WHEN THE ELEMENTS OF THE ANTISEPTIC METHOD FAIL.

To make this chapter exhaustive, it would be necessary to review all the substances proposed in the last ten years, and this simple examination would assume frightful proportions. It is unnecessary, however, to undertake this task, for the ingenuity of the surgeon will be able to meet the emergencies which arise when the ordinary means fail. It will be sufficient for him to bear in mind the following precepts:—

First. Emollient epithems of various kinds are nests all ready for micro-organisms.

Second. So-called pure water is often loaded with enemies, as Pasteur has so well demonstrated. Therefore, the use of epithems and pure water should be abandoned.

Third. Carbolic acid is now so common that aqueous solutions can be made almost anywhere.

Fourth. All antiseptics of the same family may be employed, as borax, alum, tannin, sulphate of zinc, chloride of zinc, and such other agents.

Fifth. Among the vegetable substances easily found in the fields, the green rind of the walnut, the walnut-leaf, oak-bark, afford decoctions which are sufficiently antiseptic in media which are not very dangerous. Tar is a substance of the very greatest worth.

Solutions of carbolic acid in glycerine and especially in oil are of peculiar value, since the acid, when dissolved in these substances, is scarcely irritant, and a wound may be dressed

with a twenty-per-cent. oily solution without excessive irritation. Nevertheless, it is better to use solutions of less strength, as the more powerful lay one liable to toxic accidents. Thus, dressings with ten- or even five-per-cent. carbolyzed oil are of very great service where frequent renewal is demanded.

Wadding impregnated with five- or ten-per-cent. carbolyzed glycerine makes a valuable dressing. Even in an antiseptic hospital, when patients enter with abundant suppuration, it performs important service.

I used often to employ, especially in dressing patients operated on for strangulated hernia, layers of agaric saturated with weak carbolic solution. In other cases, I used charpie soaked in this solution, always observing the other precautions of the method, and covering the dressings with an impermeable; in suppurations I had thus a veritable cataplasm.

In using vaseline or boracic ointment, one can easily follow out the principles of the method in simple cases.

CHAPTER XXXIII.

FORMULÆ FOR PREPARING THE MATERIALS EMPLOYED IN THE TRUE LISTER DRESSING.

Carbolic acid.

It is well to remember that there is a much wider choice of antiseptics than most of us have been accustomed to suppose. Professor Lister has not simply introduced carbolic acid into surgical practice; he has invented a method which demanded the employment of the best antiseptics. After a great many trials, he has selected several which he has found useful. But, up to the present time, he has found no agent which is as valuable as carbolic acid for the habitual destruction of micro-organisms and for its action upon recent wounds. It cannot be said to be the best in every case, and for certain purposes Lister does not use it. He recommends other substances in cases where the method cannot be rigorously applied. I am quite certain that the surgeon who, after having become familiar with the principles of the method, attentively studies the chapter on its practice, will be able, even though he cannot obtain the materials for the perfect Lister dressing, to institute an antiseptic treatment which will always give favorable results, because the first attempts of the master himself, imperfect as we must consider them, constituted a great advance in surgery.

The employment of carbolic acid presents indisputable and undenied disadvantages, which, however, are compensated for by advantages which are not less indisputable. Its odor, causticity, and poisonous properties are objections, as we

have already seen ; and I would remind all who contemplate using it that, in spite of the progress of industry, it is still burdened with a multitude of impurities. We should never employ the uncrystallized acid ; and there is some choice even among the crystallized specimens, for they are liable to contain various alkaloids, which, more than any other substances, impart to it harmful properties. That which has most transparency and least odor has as powerful antiseptic qualities as any, and the fewest disadvantages.

The carbolic acid which combines these conditions is the product which is known in England as absolute phenol, and possesses the additional merit of being so much more soluble that a five-per-cent. aqueous solution can be made without the addition of alcohol.

The disadvantages of carbolic acid may be remedied by associating it with other substances, one or another being chosen according to circumstances. For example, being volatile and very soluble in alcohol, it is given up by the liquid with great ease, indeed, we may say immediately. Thus the alcoholic solution is caustic and may furnish rapidly large quantities of the acid, when an extensive and powerful application is necessary. In water, the acid is a little more fixed, and thus the aqueous solutions are more manageable and are very widely used ; but even water parts with the acid so speedily that these solutions are bad agents for permanent dressings.

In order to insure the solution of the common varieties of the acid, it is always the rule to add alcohol ; but as little as possible should be used, for, if there is a considerable proportion of alcohol, these solutions really become a little irritant.

Some little care should be devoted to the preparation of the aqueous solutions. They should be made some time

before they are to be used, as, after standing a while, any undissolved globules may be more easily detected, and the solution will then be filtered; for, if these globules be allowed to come in contact with the skin, they will produce a disagreeable burn.

I have many times compared the effects of very pure and of impure carbolic acid. One-to-forty solutions of the former, in permanent contact with the tissues, cause no inconvenience; solutions of the latter of the same strength sometimes produce vesication.

In order to avoid the disadvantages arising from the addition of alcohol, I dissolve the acid in glycerine, and then add the water without alcohol. Glycerine dissolves the acid more perfectly and rapidly than alcohol does. The proportion required is the same as that of alcohol. Solutions thus prepared are much less caustic and less disagreeable to employ than the others. They may be used for all purposes. It is true that, when they are used for the production of the spray, the tubes are more easily clogged; but this inconvenience may be avoided, and we have the advantage of a much more perfect cloud.

Aqueous solutions.

The following are the formulæ for the most commonly used solutions. In order to keep the nurses from making any mistake in them, I am accustomed to color the strong solution red.

Strong aqueous solution, red.

Carbolic acid crystals	50 grams.
Alcohol	50 "
Water	1,000 "

Weak aqueous solution.

Carbolic-acid crystals	25 grams,
Alcohol	25 “
Water	1,000 “

Very strong alcoholic solution.

Carbolic-acid crystals	10 grams,
Alcohol	50 “

Instead of these, I recommend the following solutions, which, as I have said before, are preferable, even for the spray.

Strong aqueous solution, red.

Carbolic-acid crystals	50 grams,
Glycerine	50 “
Water	1,000 “

Weak aqueous solution.

Carbolic-acid crystals	25 grams,
Glycerine	25 “
Water	1,000 “

Carbolized oil and glycerine.

The acid dissolves well in both these substances, and the solutions are very manageable. The oil parts with the acid which it contains much more slowly than either alcohol or water; and, therefore, before the employment of the gauze, it was the carbolized oil which Lister selected for his anti-septic agent.

Two different strengths of the oil are generally used.

The first is employed to lubricate catheters, trocars, specula, etc., and is composed of

Carbolic-acid crystals	5 grams,
Olive oil	100 “

The second is used in dressings, and contains —

Carbolic-acid crystals	10 grams,
Olive oil	100 “

Certain dressings which require to be frequently renewed are made of lint or charpie saturated with this oil. In France, in place of lint, we use wadding or compresses impregnated with it. The dressings often need to be changed twice a day.

I have often applied such an oiled compress to inflamed parts in place of a cataplasm, putting a layer of wadding above it, and outside of this the impermeable. The patients seem to be as much relieved as by a poultice, and do not incur the dangers inherent in the dirty epithems.

Gauze.

This is made of fine, unbleached tarlatan, washed, to make it more pervious, and dried. Pieces five or six meters long are folded into squares, heated in a stove, and then treated with the following mixture: —

Carbolic-acid crystals . . .	1 part by weight,
Common resin	5 parts “ “
Paraffin	7 “ “ “

The resin and paraffin are to be mixed in a water-bath, and the carbolic acid added gradually.

The mixture is applied by means of a syringe with a large nozzle, which is perforated with a number of holes, each

square of the gauze having injected between its folds a quantity of the liquid about equal to its own weight. Then it is returned to the stove for several hours, in order that the mixture may be equally diffused; or the same result may be obtained by the action of a press.

Gauze thus prepared, though light, is flexible and firm, is of a yellowish color, and exhales a strong odor of carbolic acid. It should be kept in an air-tight canister to protect it from heat, which favors its evaporation. In fact, if it is warmed even by the heat of the skin, it gradually gives up its acid.

This prepared gauze is the most expensive part of the dressing, because so much of it is used; and yet it was well made formerly at the Edinburgh Infirmary for less than six cents a meter; and a dressing for the thigh requires scarcely two meters. In Paris one can hardly get it for ten cents a meter. However, all the large pieces may be washed after they have been used, and then recharged with the resinous mixture, thus effecting a considerable saving; for the great cost is in the gauze, and not in the mixture which saturates it.

Roller bandages made of this material are remarkably good, being very flexible and strong, and not slipping as ordinary bandages do.

Various other materials have been offered as substitutes for the gauze; but whatever they are, certain indispensable properties should be required of them. In the gauze, the carbolic acid is the fermenticide. The resin has the property of holding the acid a long time, and letting it escape only very slowly. The paraffin is a neutral substance, but it imparts desirable consistency, does not change the resin, and keeps the gauze from adhering to the skin, an accident which would be very vexatious.

Protective.

This material is prepared by coating fine, well-made oil-silk with a delicate layer of copal varnish, and applying outside of this a pellicle of dextrine. It is not in itself antiseptic, but it protects the wound from the irritant action of the carbolic acid in the gauze. Simple oil-silk will not prevent the passage of the acid, as I have found to my sorrow; hence the application of the varnish, which is impermeable to it. The dextrine is designed to retain a little of the antiseptic solution in which the protective is dipped before being placed on the wound.

So minute a quantity of the protective is required for each wound that a little will last a long time, and its cost is not worth considering.

In preparing it we take common oil-silk and cover both surfaces with a film of copal varnish. When this is dry, we apply with a brush a thin layer of the following mixture:—

Dextrine	7 parts,
Powdered starch	2 “
Cold one-to-forty solution of carbolic acid	16 “

The last ingredient is used to facilitate the deposition of a pellicle of dextrine.

Mackintosh.

This is fine and flexible cotton cloth, coated with a delicate but tough layer of rubber. The flexibility of this material is remarkable, for it will stand any amount of crumpling without cracking or breaking, and the impermeable layer does not peel at any point. This is an important quality from an economic point of view, for it permits the repeated use

of the mackintosh, and thus saves a very considerable increase in the cost of the dressing. After each dressing the pieces of this material should be put into soap-suds, and then allowed to remain for some hours in the strong solution of carbolic acid. They are then dried, and, at the next dressing, just before putting them between the two outer layers of the gauze, it is well to carefully moisten both sides with the weak solution, in order to destroy the germs which may have been deposited upon them. In this way, two pieces of mackintosh can be made to answer, as well as more, during the entire treatment after an operation, and, indeed, in many different cases, thus greatly reducing the estimated cost of the dressings. The least solution of continuity is a source of danger, and every piece of mackintosh which is not perfect should be thrown away.

In Germany they use thin gutta-percha instead of mackintosh, considering it less expensive.

Chloride of zinc.

This substance, being one of the most powerful antiseptics known, is of great value. The persistence of its antiseptic effect is the peculiar property for which it is especially celebrated, and therefore it is called for in cases where we desire to purify infected wounds in the most thorough manner. The solution which is used in all these cases is the following:—

Chloride of zinc	8 grams,
Water	100 “

This solution is very caustic, and leaves upon the wound-surfaces which it touches a thin eschar, which, however, does not hinder union by first intention. Its employment is indi-

cated in wounds which have been exposed for a long time, and still more in those cases where complete protection by the antiseptic method is impossible. I would recommend it in certain cases of cold abscess, where the walls of the cavity are too well organized.

But I would especially call attention to its employment where carbolic acid cannot be used for fear of its toxic effects. We must then content ourselves with solutions of one or two per cent., or even weaker. My experience is not sufficiently varied to warrant me in stating the exact limit of its antiseptic power.

Catgut.

The manufacture of carbolized catgut is so poorly understood by makers generally that I would advise surgeons to make it for themselves, and refer them to what is said on this point in the chapter on ligatures.

To get a solid, aseptic, and sufficiently firm thread, the following directions should be exactly observed:—

Carbolic-acid crystals	20 grams,
Water	2 “
Olive oil	100 “

Pour the water upon the crystals, and then make an emulsion by vigorously shaking the dissolved acid with the oil. Put this into a bottle, in the bottom of which are placed some pebbles or glass rods to keep the cord from touching the water which settles there. Then place the pieces of gut in the bottle, seal it hermetically, and let it stand five or six months. The cord is rarely solid before the end of this term, and the longer it remains, the better does it become for all purposes.

A great deal depends upon the original quality of the gut.

That which we find in commerce is usually poor stuff. The very fine cords are useless, except for some particular sutures. The French catgut is the most reliable, and, by the advice of a well-known lute-maker, I select the unbleached cords, which endure strain the best. I have prepared very large cords, quite sufficient to secure the pedicle in ovariectomy.

Carbolized silk.

In cases where he does not care to use either catgut or silver wire, Lister often has recourse to silk thread. This is prepared by dipping it into a mixture consisting of two grams of pure carbolic acid and sixteen grams of melted wax. The thread is then drawn through a cloth, in order to distribute the wax evenly over the surface, and to remove the excess.

Boracic acid and its preparations.

Boracic acid is an excellent antiseptic, but the results obtained with it as a topical application are comparatively mediocre. While it is very unfavorable for the development of the phenomena of putrefaction, it does not powerfully modify the putrescible substances which are always in excess in the vicinity of wounds. Its moderate solubility makes its use as a wet topical unsatisfactory. On the other hand, it has the advantage of being neither caustic nor irritant. It renders very good service in superficial wounds where there is no prospect of a considerable discharge; in the last part of the treatment of a wound; all through the treatment, when the injured parts and those in the vicinity are peculiarly liable to irritation, as the conjunctiva, for example; and whenever large injections must be made into cavities from which fluids return imperfectly or with difficulty.

For all these purposes we use the saturated solution. Water at the ordinary temperature will hardly hold four per cent. of its weight of the acid. It may, however, be used as a dry dressing in the form of

Boracic lint.

Taking advantage of the power of boiling water to dissolve nearly a third of its weight of boracic acid, we make a very valuable preparation. Into boiling water which is saturated with boracic acid we dip pieces of lint, that soft and porous cotton material which, in the English hospitals, replaces charpie. On being dried they are found to have almost doubled in weight. In fact, their interstices and surfaces are covered with crystals of boracic acid, which are soft and not at all injurious to the skin.

In using boracic lint, we moisten it in a solution of the acid, apply it to the wound, and cover it in with the mackintosh.

Boracic ointment.

This is a somewhat unappreciated preparation, but it is capable of rendering capital service either as a dressing complete in itself, when there is little discharge, or in case we wish to introduce an unguent into a carbolic dressing. Lister gives the following formula:—

Pure boracic acid . . .	1 part by weight,
White wax	1 “ “ “
Paraffin	2 parts “ “
Almond oil	2 “ “ “

Mix the wax and paraffin by heating them with the oil; then stir them up thoroughly with powdered boracic acid until the mixture thickens. This ointment I have found to be

rather hard and not very manageable, and I prefer that which is made by the formula below:—

Oil of sweet almonds	210 grams,
Paraffin	60 “
White wax	30 “
Boracic acid	60 “

This ointment is spread on fine, soft cotton or linen. It is an excellent application to wounds in the vicinity of orifices, as about the face, favoring union by first intention, being unirritating and a good antiseptic, constantly giving up the acid to the liquids which drain away. It is very serviceable even in cases where putrefaction cannot be avoided, and one can only diminish its effects.

Vaseline.

This transparent and unctuous substance, also known as petroleum jelly, is a product derived from petroleum, and, unlike fats, is absolutely imputrescible. It does not become rancid, and for a long time it has been of great service as a substitute for the greasy topics, especially in ophthalmic surgery. Like glycerine, it dissolves many medicinal substances. By triturating it with boracic acid, we get a sort of boracic ointment which is a fine antiseptic.

In his recent work, Nussbaum advises its employment to disinfect the hands of the surgeon, and to protect them from the irritant action of carbolic acid. He says: “The hands of the surgeon who has much operating to do soon become rough, often even painful, from the action of the carbolic solution. Therefore, I have lately anointed my hands with carbolized vaseline made by the following recipe:—

Carbolic-acid crystals	10 grams,
Vaseline	90 “

This mixture penetrates all the pores and creases, thoroughly disinfects the hands, and prevents their becoming rough."

Jute.

Good antiseptic preparations may be made of tow impregnated with antiseptic substances. There are cases in which oakum gives excellent results. On account of its cheapness, the Germans highly recommend a material which is called jute. It is also known as Arracan hemp, and is a tow made from the fibre of divers varieties of corchorus, especially the corchorus capsularis, cultivated in Bengal, and for a long time used in Europe for the manufacture of coarse mats and bags.

Thiersch, who has particularly advised its employment, salicylates jute by soaking it in the following solution, and then drying it:—

Salicylic acid	75 grams,
Glycerine	500 "
Water at 80° C.	4,500 "

We may also impregnate the simple jute with the weak or the strong solution of carbolic acid, just as we would charpie.

Drainage tubes.

Being an essential part of the dressing, the drainage tubes should always be prepared in advance. We select firm tubes, and by preference take the red or black rubber, as they are much purer and less easily acquire odors by contact with organic matters. They are prepared by fastening a single or double thread to one end, and putting them into a wide-mouthed bottle filled with strong carbolized water, in which

they are kept until needed. The rubber becomes impregnated with the acid, and the tubes are always ready for use.

Horsehair is prepared for drains by washing it in an alkaline solution to free it from impurities and the greasy matters which adhere to it, then doing it up in fasciculi of various sizes, and keeping them in a bottle of carbolized water.

Salicylic and thymic acids.

These are the chief rivals of carbolic acid ; but, in spite of their real value, their employment has always been extremely limited. Thiersch, of Leipsic, has been foremost in praise of salicylic acid, but his results have been greatly inferior to those of surgeons who use the carbolized dressing.

Salicylic acid is so irritant to the respiratory passages that it is impossible to use it for the spray. Even the handling of pieces of dressing which are well impregnated with the acid is sufficient to annoy the assistants.

Salicylic acid is so slightly soluble that we must either employ very weak aqueous solutions (one part to three hundred), or add a considerable quantity of alcohol.

Thymic acid is very irritant and even less soluble than the salicylic. The solutions which are employed have no antiseptic value. It is, moreover, very costly — an objection of no moderate consequence.

The antiseptic gauze made with thymol or thymic acid, in a manner similar to that employed in making carbolic gauze, is used to a very limited extent. It is worthy of note that, at the last congress of German surgeons, those who were formerly very enthusiastic admirers of thymic acid declared that it had little value, and that they had been obliged to return to carbolic acid. This was a result which could easily have been predicted.

For a long time thymic acid had been used in France, where it was known as an antiseptic, but was never extensively employed on account of its irritant and caustic qualities, its insolubility, and its costliness.

Salicylic wadding.

It is proper to state that we can utilize certain preparations like salicylic wadding to complete a dressing. This is wadding impregnated with salicylic acid, by immersing it in a solution of the acid in alcohol and water, and then drying it. The quantity of acid in this preparation can be regulated by making a stronger or weaker solution. Nussbaum's method of making a ten-per-cent. salicylic wadding is as follows:—

Salicylic acid	1 kilogram,
Alcohol	1 “
Water at 80° C	60 liters.

Dissolve the acid in the alcohol, and add the water. Take ten kilograms of wadding which has been cleansed of grease, and immerse it in this solution for several hours. Then spread it on boards to dry.

In a similar way salicylic jute is prepared.

Compound preparations.

An idea which I consider fruitful is that of combining several antiseptics. I have had but little experience in this line, but I can point to M. Siredey, who associates thymic with carbolic acids. I would also call attention to the preparation of a Paris apothecary, which is known as the antiseptic liquor of Pennès, and contains salicylic and thymic acids and the essence of eucalyptus. It is a powerful antiseptic. It is quite probable that a judicious combination of antiseptics will permit us to reach certain kinds of micro-organisms, which are sensitive to a compound antiseptic only.

Sulphite of sodium.

It may be worth while to notice the employment of this substance, so highly extolled in Italy. According to the confession of Dr. Angelo Minich, who has urged its methodical employment in an important work which was published in Venice in 1876, it is inferior to carbolic acid, but it is plain that, in some cases, we may make use of a good part of the formulæ which he gives. He recommends it as cheap, unirritant, and as a preventive of even erysipelas. For the spray and dressings he uses this solution:—

Sulphite of sodium	100 grams,
Glycerine	50 “
Water	1,000 “

He makes the dressing by applying a layer of gutta-percha upon the wound, strips of simple gauze steeped in the solution, a thick layer of purified cotton, and a bandage of gauze soaked in the antiseptic solution. He has even replaced the wadding with flaxen tow or salicylic hemp. The dressing is renewed as is the genuine antiseptic dressing.

Cataplasms are replaced by compresses saturated with the hot solution.

When the wound begins to cicatrize, the wet dressing is no longer favorable, and Minich advises the application of a cloth spread with this ointment:—

Tannate of lead	4 grams,
Lard	30 “
Sulphite of sodium	4 “

Above this is placed a layer of salicylic wadding, and over all a thin layer of gutta-percha.

APPENDIX.

Comparison of Some of the Principal Measures of the Metric System with those in Common Use.

MEASURES OF LENGTH.

- 1 Millimeter = 0.03937 inch, or about $\frac{1}{25}$ inch.
- 1 Centimeter = 0.3937 inch, or about $\frac{1}{2.54}$ inch.
- 1 Meter = 39.37 inches, or about 40 inches.
- 1 Kilometer = 0.62137 mile, or about 1100 yards.

MEASURES OF WEIGHT.

- 1 Milligram = 0.0154 grain, or about $\frac{1}{64}$ grain.
- 1 Centigram = 0.1543 grain, or about $\frac{1}{6.4}$ grain.
- 1 Gram = 15.432 grains, or about $15\frac{1}{2}$ grains.
- 1 Kilogram = 2.2046 avoirdupois pounds, or about $2\frac{1}{8}$ pounds.

MEASURES OF CAPACITY.

- 1 Milliliter or cubic centimeter =
16.2293 minims, or about 16 minims.
- 1 Liter = 2.1132 pints (U. S. wine measure), or about 2 pints, 1
fluid ounce.

Comparison of Thermometric Scales.

Centigrade.	Fahrenheit.	Centigrade.	Fahrenheit.
0.	32.	40.5	105.
10.	50.	41.	105.8
20.	68.	41.1	106.
25.	77.	41.2	106.2
30.	86.	41.6	107.
35.	95.	42.	107.6
35.5	96.	42.2	108.
36.1	97.	42.5	108.5
36.6	98.	42.7	109.
37.	98.6	43.	109.4
37.2	99.	43.3	110.
37.5	99.5	43.9	111.
37.7	100.	44.4	112.
38.	100.4	50.	122.
38.3	101.	60.	140.
38.7	101.7	70.	158.
38.9	102.	80.	176.
39.	102.2	90.	194.
39.4	103.	100.	212.
40.	104.		

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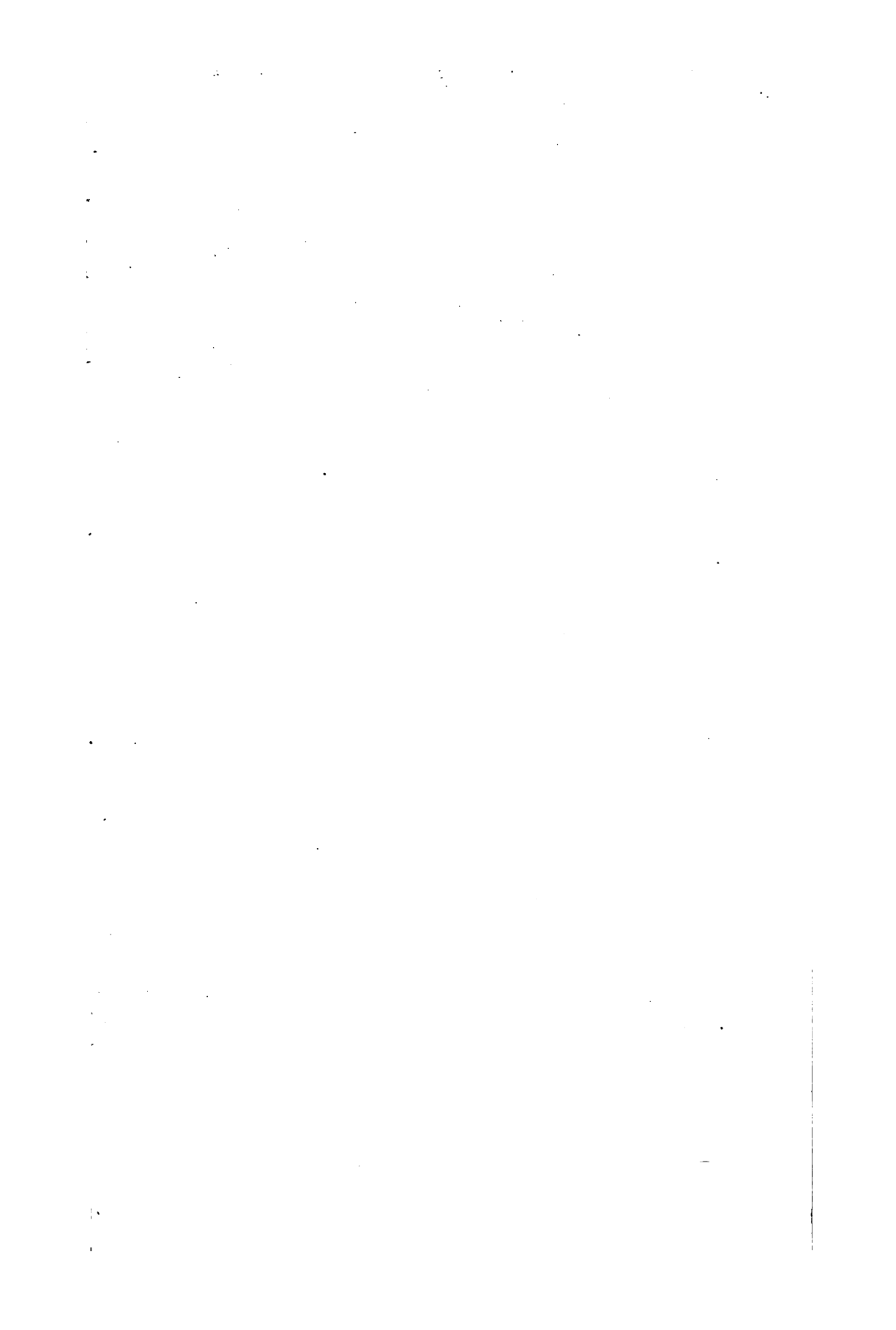
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